WHOI-2000-04

Woods Hole Oceanographic Institution

Tidal Observations at Ria Formosa, Algarve, Portugal

by

Paulo Salles
Stephen P. O'Malley
George Voulgaris
David G. Aubrey

May 2000

Technical Report

Funding was provided by WHOI Sea Grant, EU MAST III Program, UNAM, Mellon Foundation and Rinehart Coastal Research Center.

WHOI-2000-04

Tidal Observations at Ria Formosa, Algarve, Portugal

by

Paulo Salles
Stephen P. O'Malley
George Voulgaris
David G. Aubrey

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

May 2000

Technical Report

Funding was provided by WHOI Sea Grant, EU MAST III Program, UNAM, Mellon Foundation and Rinehart Coastal Research Center.

Approved for Distribution:

Robert S. Detrick, Chair

Department of Geology and Geophysics

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This project is part of the field campaign of the MAST3 Project InDIA (Inlet Dynamics Initiative: Algarve) conducted in the lagoon of Ria Formosa in Algarve, Portugal.

Whereas the InDIA fieldwork partners focused on the New Ancão Inlet in the Ancão Peninsula, with intensive field measurement in its vicinity (2.5 km^2), the work presented here covers the entire lagoon and its six inlets. The field campaign was meant to provide detailed data for the calibration and validation of a hydrodynamic numerical model. The model will ultimately simulate the hydrodynamics of the Ria Formosa lagoon and will serve as a tool to analyze the persistence of multiple tidal inlets in the system and identify the processes responsible for such persistence.

For the model setup, the field measurements are needed to provide (i) updated bathymetry of the estuary, and (ii) detailed surveys of each inlet. In situ measurements of (iii) water level fluctuations within the estuary and (iv) current velocities are required for calibration purposes, as well as for validation (in instances where more than a single data set is available). Items (ii), (iii) and (iv) are covered by this report.

The survey of the inlets, item (ii), was conducted from a survey vessel using Differential Global Positioning (DGPS) and a high precision Fathometer.

The water level fluctuations within the estuary, item (iii), was obtained using tide recorders. Internally recording pressure/temperature loggers (PTL) were deployed at different locations in the lagoon in order to document the tidal characteristics throughout the system. The approximate location of the deployments was determined from maps trying to cover the entire lagoon and the actual location was eventually determined *in situ* to ensure an optimal location in terms of navigability, security and data quality. In addition an Acoustic Doppler Velocimeter was deployed offshore, in the vicinity of the Cacela Inlet, in order to record the offshore tide.

Finally, the current velocities at the inlets and other selected locations, item (iv), was obtained using a broadband high frequency Acoustic Doppler Current Profiler (ADCP).

This report gives first a brief description of the instrumentation used in the field (section 2), then describes the methods used to deploy the instruments, perform the surveys and gather the data (section 3), and explains the procedures for data reduction and shows some results (section 4 and Annex). All the raw and processed data is stored in electronic format.

2. INSTRUMENTATION

2.1 Tide Gauges

Tidal data were acquired using internally recording pressure/temperature loggers. For this program Brancker TG205 gauges were used. The Brancker instruments were chosen because of their proven reliability, ease in use and they provide measurement accuracies appropriate for this project. Each instrument was calibrated at the Woods Hole Oceanographic Institution prior to deployment. The accuracy and nominal operating range for each instrument is provided in Table 2.1.

Instruments use a Druck strain gauge to measure total pressure (P_{atm} + P_{H2O}). Within each sampling period, a user-defined number of "burst" samples were taken and then averaged to provide a single value for that period. Although the number of bursts is programmable, the interval between each measurement is fixed at 0.5 seconds. Battery and data storage limitations over the length of deployment defined the maximum amount of data that can be acquired. The typical sample interval is six minutes which when deployed over a full lunar cycle provide adequate data to derive the harmonic constituents of the local tides.

Table 2-1 Tide Gauge Specifications.

Instrument	Accuracy (cm)	Resolution (cm)
TG 1	0.5	± 1.0
TG 2	0.7	± 1.5
TG 3	1.1	± 2.2
TG 4	1.2	± 2.5
TG 5	1.2	± 2.5
TG 6	1.2	± 2.5
TG 7	1.2	± 2.5
TG 8	1.2	± 2.5
TG 9	1.1	± 2.2

2.2 ADCP

An acoustic doppler current profiler (ADCP), manufactured by RD Instruments was used to measure and record current velocity profiles at each inlet in the Ria Formosa system. The ADCP transmits an acoustic pulse of known frequency (1200kHz) into the water and calculates the current velocity based on the change in frequency (Doppler shift) of the returning echoes. The unit provides high-resolution vertical profiles of the current by reporting the speed and direction of flow at discrete layers (or bins or depth cells) below the survey vessel. Each vertical strip containing depth cells is called an ensemble.

In shallow coastal systems, bin sizes are usually chosen to have a length of 1 meter or less. The data will provide a single averaged velocity and direction from

the multiple samples taken within each bin. Near surface data are not provided due to the displacement of the instrument and a "blanking period" during which time the ADCP does not listen for returns immediately after transmit. Data at the bottom layer are usually not valid due to interference from return signals from the side lobes of the transmit pulse. This invalid data zone at the bottom is usually about 6% of the water depth.

The ADCP does recognise the higher intensity backscatter from the water / sea bottom interface. These "bottom-track" data may be valuable in deriving information about other characteristics of the survey area. For example, bottom track data from cross-channel transects will provide a profile of channel depth from which the total area may be found. When multiplied by the water column velocities the total flow through the channel is provided. In addition, the speed at which the survey boat is travelling over the bottom may also determined by the return frequency shift. This velocity data combined with the ADCP's internal compass can provide recorded data of vessel speed and direction.

Navigational control was provided by differential GPS. The data are passed to a computer program which displays time display to the boat operator. When passed to the "Hypack" computer software, a plan view of the adjacent coastline, trackline to be run and an icon representing the boat are shown on the screen and updated each second. Matching data at the common time base combines the ADCP and navigation data files.

2.3 ADV

An internally recording Acoustic Doppler Velocimeter (ADV) was used to measure the current velocity and surface wave conditions at a site located seaward of the easternmost inlet. The ADV, manufactured by Sontek, measures current by transmitting a 5 MHz acoustic pulse and determining the Doppler shift of the return signal. The ADV senses three components of flow velocities of up to 5 m/s. The combination of small sampling volume and sampling rates of up to 25 Hz make turbulence measurements also possible. The instrument was chosen for this application because of it's excellent low flow performance and the ADV internal power and recording systems allow long term remote deployments.

Table 2-2 ADV Specifications.

Acoustic frequency	5 MHz
Velocity range	1 mm/s to 5 mm/s
Velocity resolution	0.1 mm/s
Sampling rate	Programmable from 0.1 to 25 Hz

This instrument was chosen because of its capability of giving pressure and directional wave data. The sampling strategy was designed accordingly. For the pressure alone, the sampling rate for each burst was 0.2 Hz, twenty four samples

were averaged to record a data point every six minutes. This burst type is consistent to the sampling design adopted for the tide gauges. For wave measurement, the instrument sampled at a frequency of 2Hz for a period of 5 minutes (i.e. 600 samples), repeating the sampling every hour. Details of the ADV deployment set-up are given in Annex B-1.

2.4 Navigational Control

Positioning of all fixed instrumentation and survey vessel tracking was accomplished using differential global positioning system technology (DGPS). A Trimble AgGPS 132 receiver was installed on the survey vessel. A single deep cycle battery (car battery) provided 12-volt DC power. Positions were referenced to the WGS-84 ellipsoid and later transformed to the local Universal Transverse Mercator projection, zone 29.

The largest source of stand-alone GPS data is due to Selective Availability (S/A). S/A is introduced by the U.S. government for the purpose of restricting full GPS accuracy to all but authorised users. The magnitude of S/A combined with other error sources (variable atmospheric conditions) results in horizontal errors of up to 100 meters. In order to remove the selective availability error, a differential correction signal was a received and applied to the raw GPS positions. This differential data is created by determining the difference between known position and that provided by GPS at precisely the same location. The resulting horizontal accuracy of the DGPS data used in this program is less than one meter, as shown in Figure 2.1.

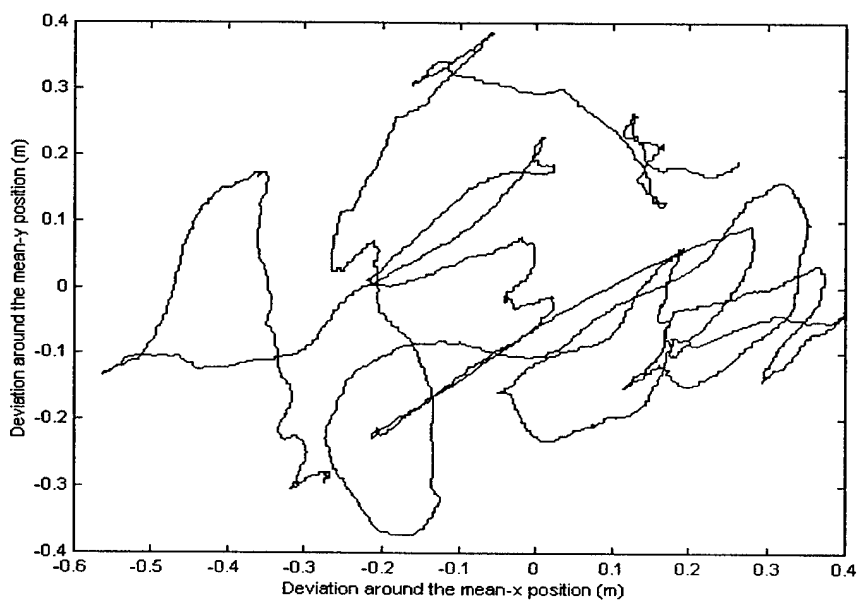


Figure 2.1 DGPS Test results.

Figure 2.1 provides results of a position repeatability test performed prior to start of fieldwork with the Trimble AgGPS 132. 3600 measurements were recorded over one hour at a fixed position. The distance from the mean position for each of the position values is less than 1 meter. This high repeatability is particularly valuable when recovering bottom mounted instruments, whose positions have not been marked at the surface, in low visibility water.

2.5 Fathometer

Bathymetric data were collected with an Odom Echotrac, dual frequency fathometer. Echo sounder transmit frequencies are manually selected (200 and 24 kHz) to provide the best resolution over variable bottom compositions. Instrument accuracy is ± 0.25 cm. This Odom depth sounder provides a paper chart record and digital depth data that are output via RS-232 serial line to the recording computer. One sounding per second is the typical update frequency when working in shallow coastal areas, which provides a depth value every 2 meters at survey speed.

The Odom fathometer is calibrated at the start of each survey day or whenever operations are moved to an area where the water properties differ from those at the last calibration site. Calibration is performed by adjusting the speed of sound value the Odom uses to calculate depths. Shallow water survey areas allow the operators to measure the true water depth with a surveyor's stadia rod and then adjust the speed of sound value accordingly until the measured and calculated values agree.

2.6 Land Survey Instrumentation

Transfer of vertical control from provided benchmarks to the installed tide gauges was performed using a Topcon model GTS 3-B total station. System components consist of the measuring unit, tripod, triple prism reflector and stadia rod. The distance measurement capability under worse case conditions (haze with visibility of 7km, sunlight and ordinary heat shimmer) is ± 5mm. Vertical accuracy under similar conditions is ± 00° 00' 3".

3. FIELD METHODS AND PROCEDURES

The deployment locations of the tide gauges and the ADVs (including an approximate location of the ADV deployed by POL near the New Ancão Inlet) and the ADCP survey locations are show in Annex C.1.

3.1 Tidal Measurements

The tide gauges were deployed at nine different locations throughout the system as shown in Figure C.1.1. These sites were chosen to maximise spatial coverage and to record data in areas that are of significance to future numerical modelling

efforts. The gauges were set at depths that insured the pressure transducers would remain submerged at low water events and that they would not cause a hazard to local boating or fishing activity. Sixteen sample bursts were taken at a rate of 2 Hz and then averaged to provide a single point for each six-minute sampling interval. This rate provided 240 samples/day. The instruments were mounted to sub-surface pipes that had been water jetted into the sea bottom. Instrument positions were obtained using the differential global positioning system (DGPS) referenced to the WGS-84 ellipsoid. Positions were recorded for use during recovery and later tidal analysis. In order to minimise the possibility of the instrument being tampered with during the deployment, the positions were not marked at the surface. Elevations of the pressure recorders were established with the land survey equipment and referenced to the Portuguese Vertical Datum (hydrographic zero =– 2.00 m with respect to the mean sea level in the port of Cascais, near Lisbon).

In addition to the data provided by the Brancker tide gauges, sea surface elevations were also recorded by the acoustic doppler velocimeter/wave gauge (ADV) deployed offshore, south of Cacela. Because of the difficulty in obtaining vertical position of the pressure transducer at such a distance offshore, the data are not directly referenced to any datum. It was assumed that the MWL offshore of Faro is the same as that at Cascais and therefore the data were considered valid for inclusion in analysis of local tidal characteristics.

3.2 Bathymetry

Bathymetric survey data were acquired using an integrated hydrographic surveying system (Hypack). Positioning of the vessel was accomplished using differential global positioning system while soundings were taken with an Odom fathometer. Electrical power for system operation was provided by a 100 watt 110 AC generator.

A 6-meter outboard motor powered vessel was configured to serve as the survey platform. The computer, fathometer electronics and DGPS unit were installed inside the vessel cabin. The fathometer transducer was mounted to the hull via an aluminium gimbal mount, which could be rotated 90° to bring the transducer out of the water during transit to and from survey sites. Since it is required that the transducer face is submerged for proper operation, it was necessary to measure this "draft" below the water surface an add the value to all raw depths. This correction function was performed by the Odom fathometer before transmittal of data to the PC.

Guidance to the vessel helmsman was provided by the survey software. The computer monitor display program shows a digitised coastline, dashed lines representing pre-defined survey tracks and an icon representing the survey boat. Digital values of the distance off line, water depth and several other parameters are also shown.

3.3 ADCP Surveys

The ADCP was configured to record and average 20 current velocity values at 0.25 m depth increments (bins) each throughout the water column. The uniformly shallow depths of the Cacela inlet allowed for improved measurement resolution by reducing the bin size to 0.10 m. A data file for each transect pair (one direction and then the opposite) was named by it's starting time and then recorded on the integrated PC via a RS-232 serial connection. Raw data were provided in hexadecimal format that was converted to ASCII during post processing. Each line file consists of a bin number, bin depth, velocity north, velocity east, resultant velocity, resultant direction, raw compass value, pitch, roll and then several columns of data quality indicators.

Cross-channel ADCP surveys were performed at six inlets of the Ria Formosa system. The ADCP transducer unit was mounted to the boat in the same manner as the bathymetry unit, where the over-the-side equipment was mounted to a gimbaled device and the DGPS antenna located directly above. During each survey, the vessel was run between two buoys that were placed at recorded positions on each side of the channel. DGPS guidance was again provided to the helmsman through the real-time display. Given the different characteristics of each location (size, depth, wave condition during the survey), the instrument was configured before each survey to optimise the data quality. For instance the sample rate, the size of the depth cells, the speed of the boat and the depth of the transducer faces below the water surface were determined before the start of the each survey, and the instrument configured accordingly. The specific instrument configuration for the New Ancão Inlet survey is shown in Annex C.1. The other configurations are available in electronic format. Each particular transect (or survey line) was chosen so that the flow and total volume of water through the inlet could be determined. The line was repeated approximately every 30 minutes over the course of a full tidal cycle (12-13 hours). At the end of each line, the vessel was brought as close to the shoreline as possible in order to maximise the area over which measurements were taken. The actual lengths of each transect varied over the course of the day as the sea surface elevation changed with tide. This variation was minimised by designing the vessel course, and saving it in the navigation computer, in a preliminary visit to the site during low tide. Plots of the designed lines (plotted over orthophotomaps from a 1991 aerial coverage) are provided in Annex C.2.

4. DATA REDUCTION AND RESULTS

4.1 Tide Data

The tidal data were collected by the 9 PTL deployed inside the lagoon and by the ADV deployed offshore. The field campaign was designed to collect tidal data for

at least a lunar cycle. The ADV was deployed offshore as planned. Due to problems with the analog board, the instrument had to be replaced and the deployment was delayed. In addition, since the deployment sites of the last two tide gauges and the ADV were close together in the easternmost part of the system, it was decided to wait for the new ADV and deploy the 3 instruments the same day. Furthermore, the ADV stopped recording nine days after being damaged by a trawling net.
Table 4.1 shows the deployment duration and the percentage of data recovered from each instrument.

Table 4-1 Tide Gauges and ADV Deployment Duration and Data Return.

Instrument	Location	Deployment dates	Deployment duration (days)	Data return
TG 1 (#8096)	Faro Beach (near bridge)	1/21 to 2/28	38	100%
TG 2 (#5078)	New Ancão Inlet	1/21 to 2/29	39	100%
TG 3 (#3853)	Main Channel	1/21 to 2/28	38	100%
TG 4 (#8711)	Main (Farol) Inlet	1/22 to 2/28	37	62%
TG 5 (#8712)	Armona Inlet	1/22 to 2/28	37	100%
TG 6 (#8710)	Olhão	1/22 to 2/28	37	68%
TG 7 (#8709)	Fuzeta	1/25 to 2/28	34	100%
TG 8 (#8713)	Tavira (Santa Luzia)	2/4 to 2/28	24	100%
TG 9 (#5081)	Cacela	2/4 to 2/28	24	100%
ADV (#9001)	Cacela (offshore)	2/4 to 2/13	9	100%

TG 4 and TG 6 failed 23 and 25 days after deployment, respectively. The pressure readings were translated to water surface elevation using the elevation of the pressure transducers (see section III), removing the atmospheric pressure and assuming a constant water density of approximately 1,024.5 $kg.m^{-3}$. The hourly values of atmospheric pressure are shown in the Annex E.

Figure 4.1 shows the records of Sea Surface Elevation. In that figure, the data from the offshore instrument #1000 was provided by the Proudman Oceanographic Laboratory. For both offshore instruments (#1000 and #9001) the mean sea surface elevation was assumed to be 2.00 m above datum, as the Mean Water Level in Cascais.

The water surface elevation records shown in Figure 4.1 were analyzed in order to derive the amplitude and phases of the tidal constituents. The results of this analysis will be used (i) to study the tidal distortion inside the estuary and thus contribute in the understanding of the hydrodynamics of this multiple tidal inlet system, and (ii) as a tool for the calibration of the numerical model.

The harmonic analysis of the tides from the data of each instrument was performed using the software package developed by the Institute of Ocean Sciences (Foreman, 1977).

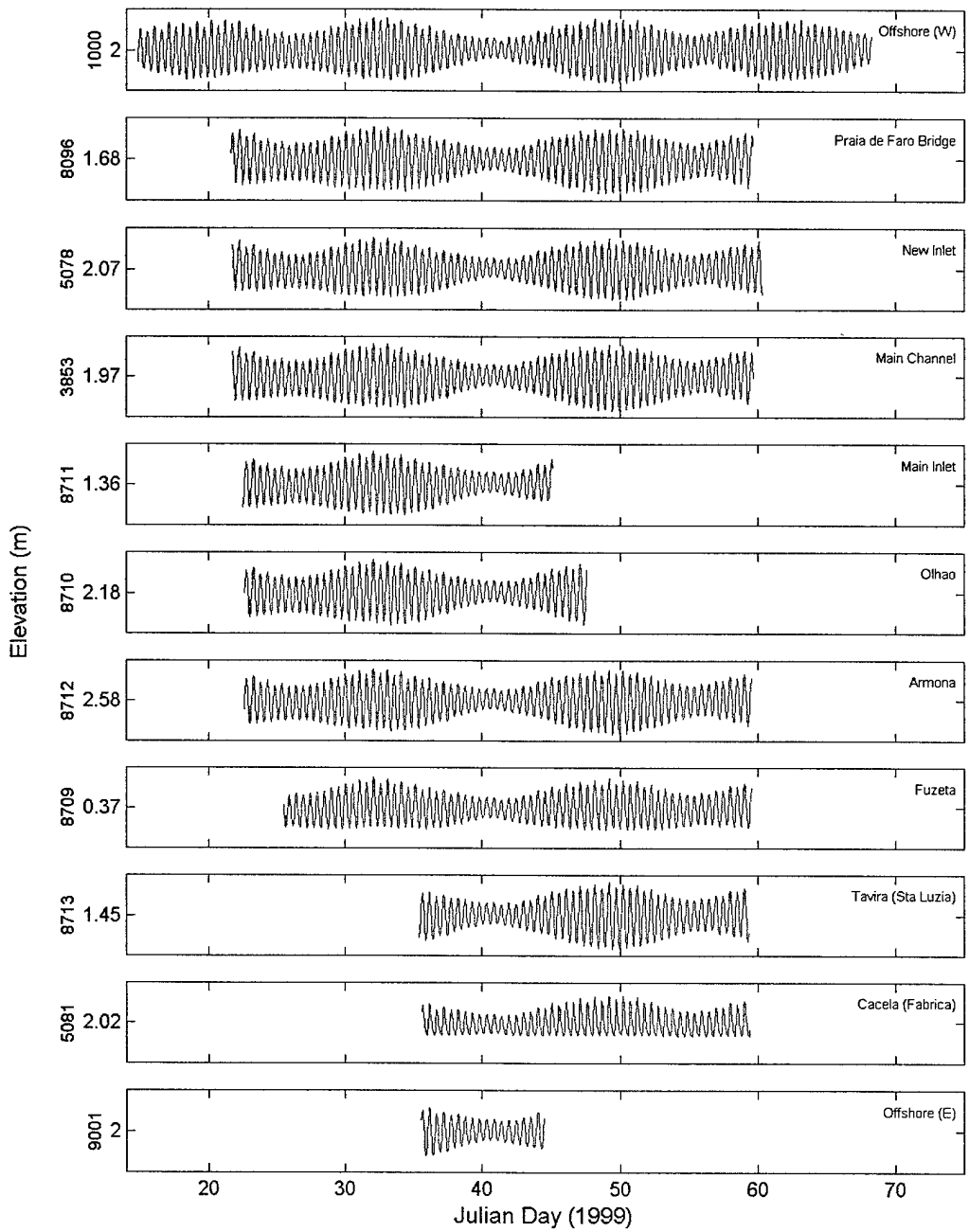


Figure 4.1 Tidal Records for Each Instrument.

The program analyzes hourly height tide gauge data for a given period of time. Amplitudes and Greenwich phase lags are calculated via a least squares fit

method coupled with nodal modulation for only those constituents that can be resolved over the length of the record. For short records with which certain important constituents cannot be resolved from the data, provision is made for the inference of the amplitude and phase of these constituents from others.

Prior to tidal analysis, the data were decimated to hourly observations and the time base corrected to GMT. Then the data were reformatted in the format needed for the program's input file, as show in Figure IV.2 for the New Ancão Inlet data.

```
 2  1.00          0. 0                  1

 8 1721 19919 8 1 39919
      5078New Inlet (Portugal)  GMT 3659 -758
1  5078        21 199999999999999999999999999999999999999999999999
2  5078        21 199999999999999999 321 321 287 237 177 124 101 119
1  5078        22 199 154 205 257 293 333 348 320 272 215 158 111 102
2  5078        22 199 128 166 216 256 292 312 303 266 213 159 115 104
.
.
.
1  5078        26 299 276 237 190 150 123 119 140 172 215 254 282 302
2  5078        26 299 288 258 215 169 138 126 139 167 212 253 290 315
1  5078        27 299 318 293 248 195 147 114 110 132 171 220 265 295
2  5078        27 299 319 302 267 214 161 122 109 126 163 213 263 301
1  5078        28 299 325 331 294 244 182 129  98  97 125 170 226 269
2  5078        28 299 302 319 301 255 197 142 107  96 125 172 227 278
1  5078         1 399 312 343 326 284 227 165 109  839999999999999999
2  5078         1 399999999999999999999999999999999999999999999999
```

Figure 4.2 Sample input file for the Harmonic Analysis software (New Ancão inlet, partial).

The record lengths used for the analysis and the number of constituents for which amplitudes and phases were derived are listed in Table 4.2.

Table 4-2 Record lengths and constituents derived for each data set.

Instrument	Hours analysed	Constituents Derived
TG 1 (#8096)	914	36
TG 2 (#5078)	928	36
TG 3 (#3853)	912	36
TG 4 (#8711)	544	18
TG 5 (#8712)	888	36
TG 6 (#8710)	600	18
TG 7 (#8709)	819	36
TG 8 (#8713)	574	18
TG 9 (#5081)	572	18
ADV (#9001)	213	10

In addition, filtering tests were performed to the data for all instruments in order to detect possible spikes and noise in the data. For that, Godin's filter was used, as suggested by Foreman (1977). This filter is a triple moving average filter, which performs three consecutive convolutions to the original data with a 10, 10 and 11 points averaging impulse response, respectively. The program applies suitable amplitude corrections to compensate for the smoothing effect of these filters.

After performing the harmonic analysis to the original and the filtered data it was found that the differences in amplitude and phase between both data sets were minimal. The results also show that the standard deviations of the amplitude, A, and phase, φ, for each tidal constituent are much larger for the filtered data than for the original data (2 to 3 times and 3 to 4 times for the short and long data sets, respectively), suggesting a higher confidence in the unfiltered data results. Furthermore, the unfiltered data results show values of A and φ which fall within the confidence intervals of the corresponding values from the filtered data results with a 68.3% confidence level (+/- one standard deviation). Therefore, it was concluded that the data did not need filtering prior to the harmonic analysis computations.

The results of the harmonic analysis for the full data sets of each instrument are listed in the Annex D.

4.2 Bathymetry Data Processing

Bathymetry data were collected at the Ria Formosa during 29-30 January, 1999. Seven files were provided for processing. Due to what was most likely operator error, data collected at the Cacela site did not contain depth values and were therefore not of use. Valid data were acquired at the following locations:

New Ancão Inlet	5.3 km	Armona	15.9 km
Main Channel	17.5 km	Fuzeta	7.3 km
Main Inlet (Farol)	4.1 km	Tavira	2.3 km

Plots of the bathymetric survey coverage are provided in Annex A. Upon initial inspection, it was determined that the real time conversion of navigational data from the WGS-84 geographic coordinates to UTM zone 29 (XY) was done incorrectly. It appears that while in the field, the transformation parameters were incorrectly set resulting in erroneous positional data. Fortunately the geographic coordinates provided by the DGPS were logged in the field. These have allowed for datum transformation to occur during post processing.

Example of *.RAW data file

```
FTP NEW
INF "PAULO" "SHETLAND" "INDIA" "ALGARVE" 0.000000 0.000000 1500.0
FIL "DAT" "" ""
ELL WGS-84 6378137.000 298.257223563
PRO UTM North 5.387639 0.9996000 0.000000 0.000000 0.000000 500000.0000
TND 12:40:48 01/29/99
DEV 0 228 "GPS"
OFF 0 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
DEV 1 16 "ODOM"
OFF 1 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
PRI 0
EOH
FIX 1
EC1 1 45648.679 11.40                                  (time, depth)
RAW 0 45648.982 4 370043.450 -74855.930 5.31 124049.00(X,Y,Lat, Long,…)
POS 0 45648.982 605933.95 4096338.31
EC1 1 45649.341 11.50
GYR 0 45649.025 124.40                                 (time, heading)
RAW 0 45649.002 4 370046.450 -74856.930 5.31 124049.00
```

Data were processed using the Hypack® hydrographic software package. Processing consisted of editing and sorting the data. A brief description of each process follows:

Editing

Editing consists of three processes, tide correction, elimination of "bad" points and conversion of the data format.

Tide Correction

Raw bathymetry and tide correction data are read into the editing program where they are aligned according to time stamp in each file. Tide correction values (provided in feet above the datum) are subtracted from the raw depth data giving water surface elevations referenced to the datum.

Elimination of "Bad " Data

Each survey profile was plotted on screen at a large scale to provide visual evaluation of the data. Spikes in the bathymetry and other data, which were obviously in error, were deleted from the file. Data were then re-plotted using a linear interpolation to replaced deleted data.

Format

The data format was changed from the raw field version, which provides extensive header information, to a more processing oriented style (*.ALL). The ALL format is required for input into the SORTING routine.

Example of *.ALL data file

```
NORMAL    ALL    UTM          12:40:48  01/29/99        WHOI          SHETLAND
INDIA    ALGARVE
GPS        ODOM                  GPS          WGS-84
1  605934.16  4096338.25   11.50  0.00 -12.11 45649.34   0.00   0.00   0.000
1  605934.36  4096338.19   11.50  0.00 -12.11 45649.67   0.00   0.00   0.000
1  605934.55  4096338.12   11.60  0.00 -12.11 45650.00   0.00   0.00   0.000
1  605934.70  4096338.00   11.50  0.00 -12.11 45650.33   0.00   0.00   0.000
```

Sorting

The Hypack SORT program performs two functions:

1) The data format is changed from the *.ALL format created by the edit routine to *.xyz where
   X = the UTM X coordinate
   Y = the UTM Y coordinate
   Z = the corrected water depth in feet

2) The number of data points within a user input radius is reduced to one. This allows plotting of data without overwriting of characters. An indication of the amount of data eliminated in this process is indicated by the "% saved" value.

Sorting Results

File Name	Number of points after processing	% Saved	Max Depth (ft)	Min Depth (ft)
Armona.xyz	9168	54.5	36.21	-8.66
Fuzeta.xyz	4289	47.5	18.19	-2.09
Main Inlet.xyz	2524	46.9	99.80	-2.61
New Inlet.xyz	3277	50.2	18.68	-5.54

The final output consists of the files shown in the previous table. These *.XYZ data files are ASCII files with one column for each field as shown below.

Example of *.XYZ data file

```
000605934.99  004096337.77  -0.91
000605936.25  004096336.99  -1.01
000605937.92  004096336.51  -0.91
000605938.81  004096337.14  -0.61
000605939.87  004096336.46  -1.21
000605941.25  004096335.62  -1.12
000605942.05  004096334.99  -0.72
000605943.78  004096333.85  -1.32
000605944.85  004096333.08  -0.92
```

4.3 ADCP Data

The ADCP delivered real time data to a computer screen and to a storage device during the length of the surveys. While these data was gathered in one computer, another computer was used to store geographic position data from the DGPS, as explained in section 2.4. These two sets of data form the bulk of the ADCP data.
As mentioned in section 3.3, each survey had its own instrument configuration. The details of each configuration, as well as the survey locations, are shown in Annex C-1 and available in electronic format.
Following is the procedure for the ADCP data reduction:

1. Transformation from raw (binary) to text (ASCII) files.
   The data output from the instrument comes in binary format. These files were converted to text files for further post-processing.

2. Matlab® routines were created to reduce the data and plot the velocity profiles for each line. Selected velocity profiles for each survey are plotted in Annex C-2 and available in electronic format. These plots show the magnetic North and East velocities throughout the measured region. They also show the bottom of the channel to have an idea of the size of the measured portion of the water column. It can be noticed that there are two layers in the water column (near the surface and close to the bottom) in which there are no measurements.
   The size of the upper unmeasured layer is the sum of (1) the "blank after transmit" due to the ringing effect in the pulse transmitted by the instrument, which for the 1,200 kHz instrument used is approximately 0.5 m, and (2) the depth of the transducer faces below the water surface.
   The size of the lower unmeasured layer is equal to the portion of the water column below the maximum range of the instrument, which in turn corresponds to the location where the signal strength drops to levels comparable to the noise level. The maximum range of the instrument is approximately 94% of the water column, minus one depth cell.

3. Due to problems with the DGPS signal reception during the ADCP surveys, not all the lines have an accurate geographic position. This problem was solved by obtaining the average position of the start point of the lines with good DGPS information and by assuming that the rest of the lines started in the same point. This assumption is valid since (1) the start point was always marked with a buoy, as explained in section 3.3, and (2) the precise location of each line with respect to the other was unnecessary given that the objective of the ACP surveys was to obtain the overall velocity profile and total discharge through the inlet and channel cross-sections.

4. Discharge computations.
   The total discharge through the inlet and channel cross-sections was computed by integrating the velocity profiles along the area covered by each line. More specifically, the procedure to compute the discharges consisted of:
   a) When appropriate, the cross-sections surveyed were subdivided into subsections as shown by the vertical dashed lines in the velocity profiles (see Annex C-2). This was done to differentiate discharges from the channels to discharges from the banks.
   b) The vertically averaged North and East velocities for each ensemble (see section 2.2) of each subsection were projected in the direction perpendicular to the ensemble orientation.
   c) The resulting velocity for a given ensemble was multiplied by the total area corresponding to this ensemble (= length of the ensemble X total depth) to account for the unmeasured layers.
   d) The total discharge was computed as the sum of all the ensemble discharges for a given line at a given time. In instances where the velocity profile for a given line had bad ensembles such that the average velocity was visibly wrong, an estimate was computed by interpolating the adjacent velocities.

   The results of the discharge computations are shown in the Annex C-3 and available in electronic format.

5. ACKNOWLEDGMENTS

We thank Wayne D. Spencer, William Robertson V and Zoe Hughes for their cooperation in the field data acquisition. In addition we would like to thank all the people from the other InDIA partnership institutions and from Portugal who helped us during the field campaign.

The work was undertaken as part of the MAST3 Project INDIA and is a result of research sponsored jointly by NOAA National Sea Grant College Program Office, Department of Commerce, under Grant No. NA86RG0075, Woods Hole Oceanographic Institution Sea Grant Project No. R/G-27, by the Commission of the European Communities, Directorate-General for Science, Research and Development under MAST Contract No. MAS3-CT97-0106, by the National Autonomous University of Mexico through a fellowship to Paulo Salles; by the Mellon Foundation through a grant to Dr. David G. Aubrey, and by the Rinehart Coastal Research Center who provided the publication costs. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its subagencies. The U.S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon.

6. REFERENCES

(1) Foreman, M.G.G., 1996. *Manual for Tidal Heights Analysis and Prediction.* Pacific Marine Science Report 77-10. Institute of Ocean Sciences, Patricia Bay, Victoria, B.C.

(2) Morlock, E. S., 1996. *Evaluation of Acoustic Doppler Current Profiler Measurements of River Discharge.* U.S. Geological Survey, Water-Resources Investigations Report 95-4218, Indianapolis, Indiana.

(3) Richard Branker Research Ltd. XL Series Submersible Data Loggers User Manual.

(4) RD Instruments, 1996. *Principles of Operation: A Practical Primer.* 2nd Edition for Broadband ADCPs.

(5) RD Instruments, 1998. *Workhorse Acoustic Doppler Current Profiler Technical Manual.*

(6) RD Instruments, 1998. *Workhorse Bottom Track Addendum.*

(7) Sontek. Acoustic Doppler Velocimeter Technical Documentation.

ANNEX A: Bathymetric Survey Coverage

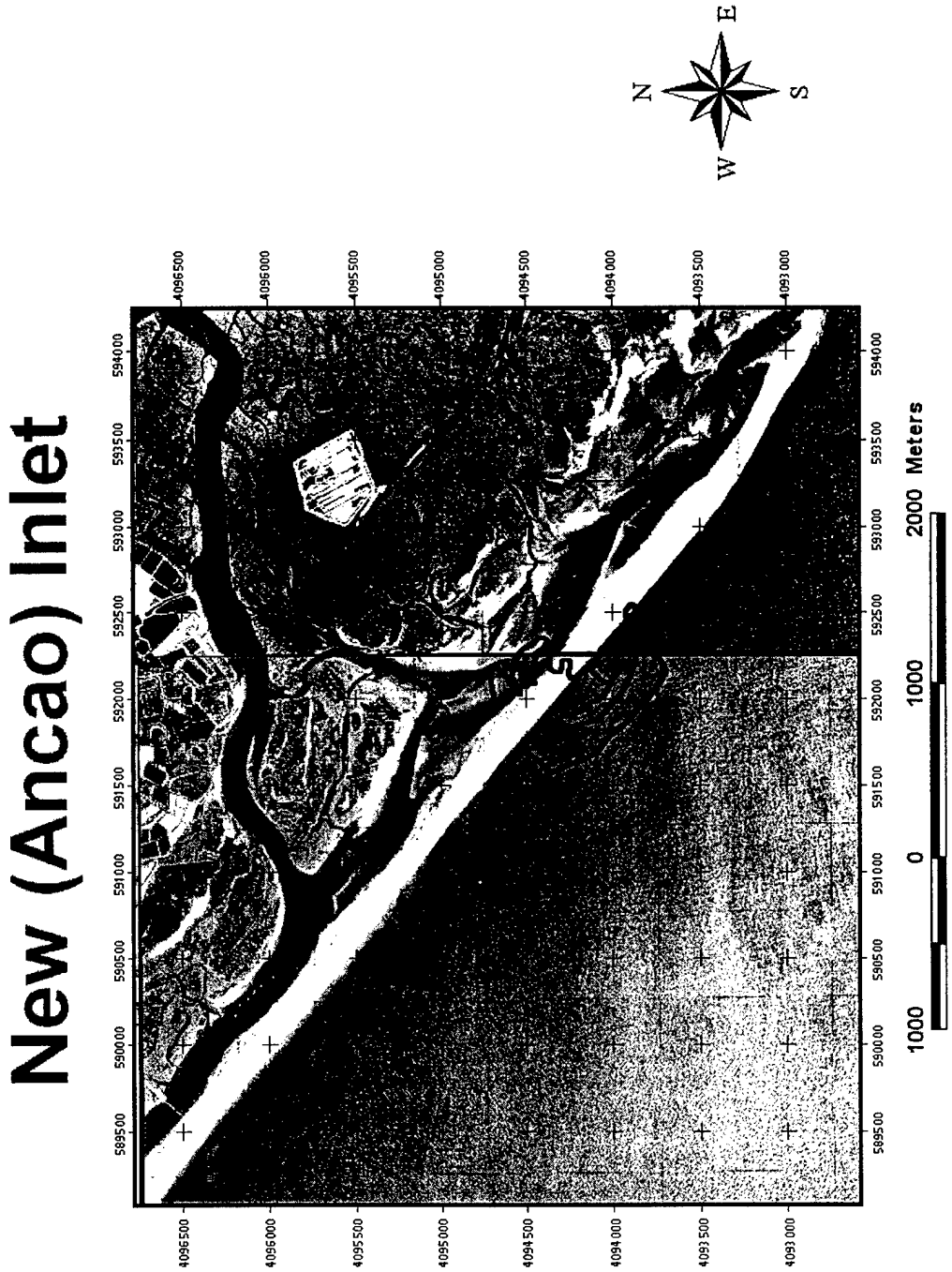


Figure A.1 Bathymetric Survey Coverage in the New Ancão Inlet.

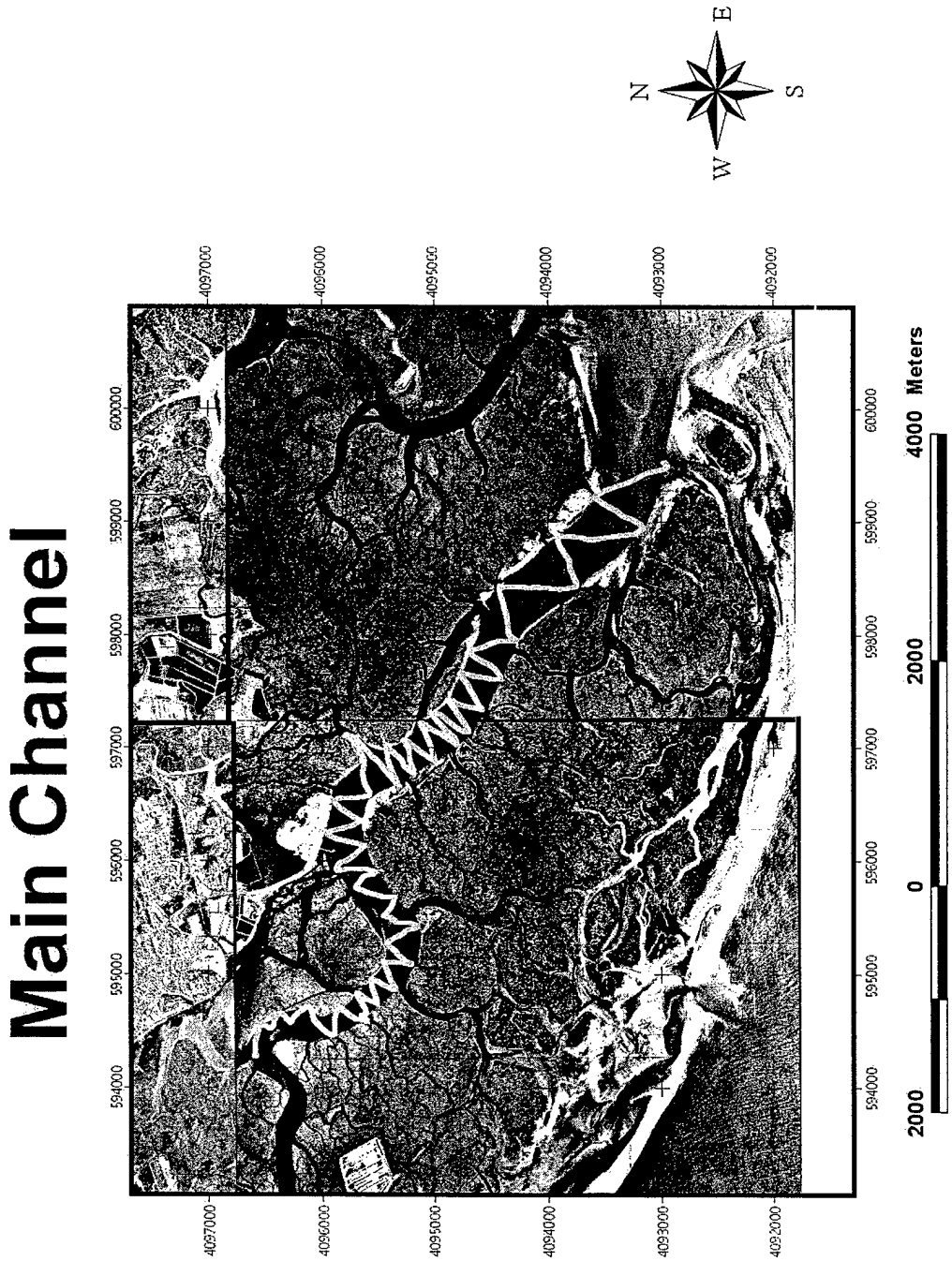


Figure A.2 Bathymetric Survey Coverage in the Main Channel.

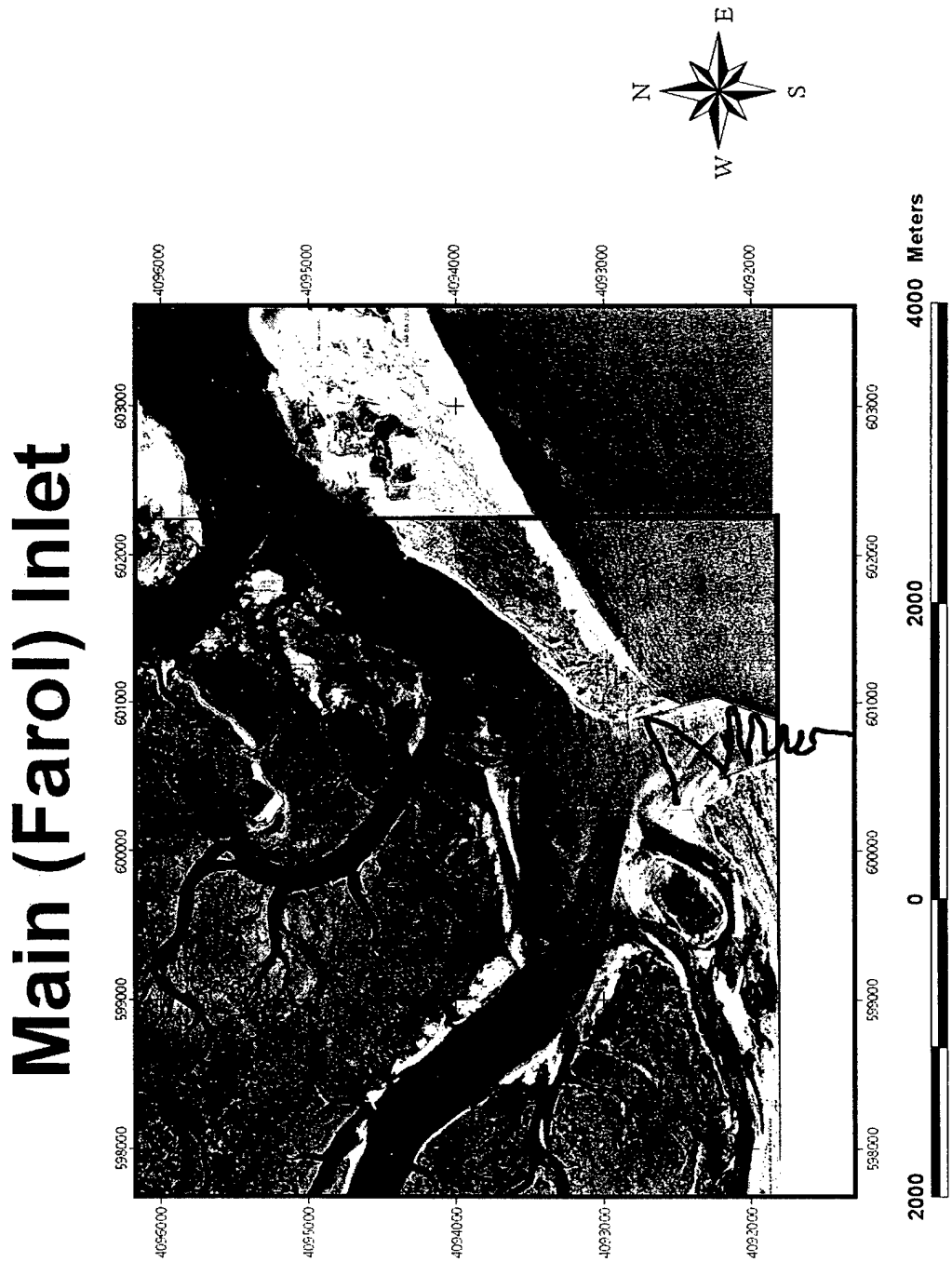


Figure A.3 Bathymetric Survey Coverage in the Main (Farol) Inlet.

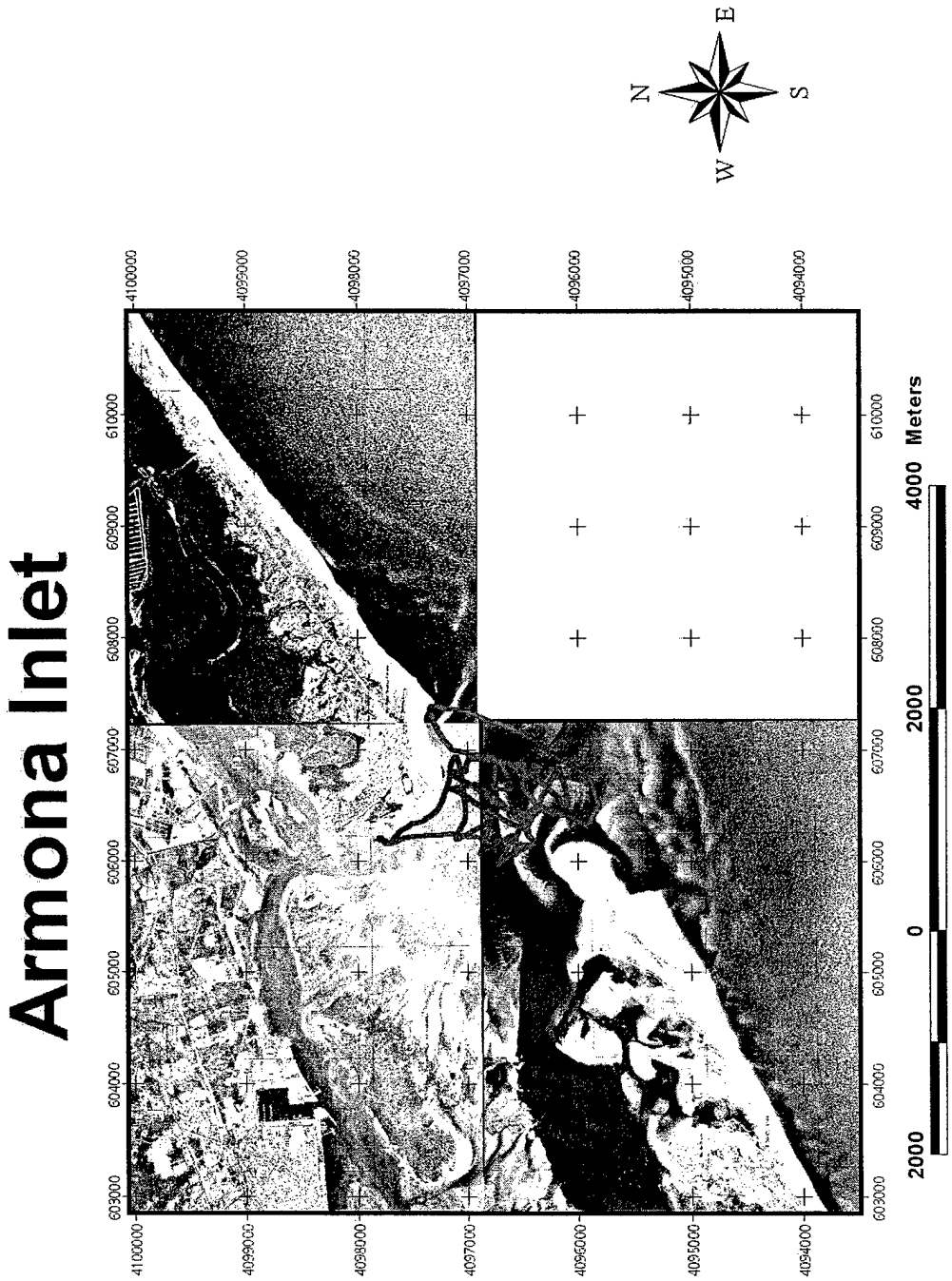


Figure A.4 Bathymetric Survey Coverage in the Armona Inlet.

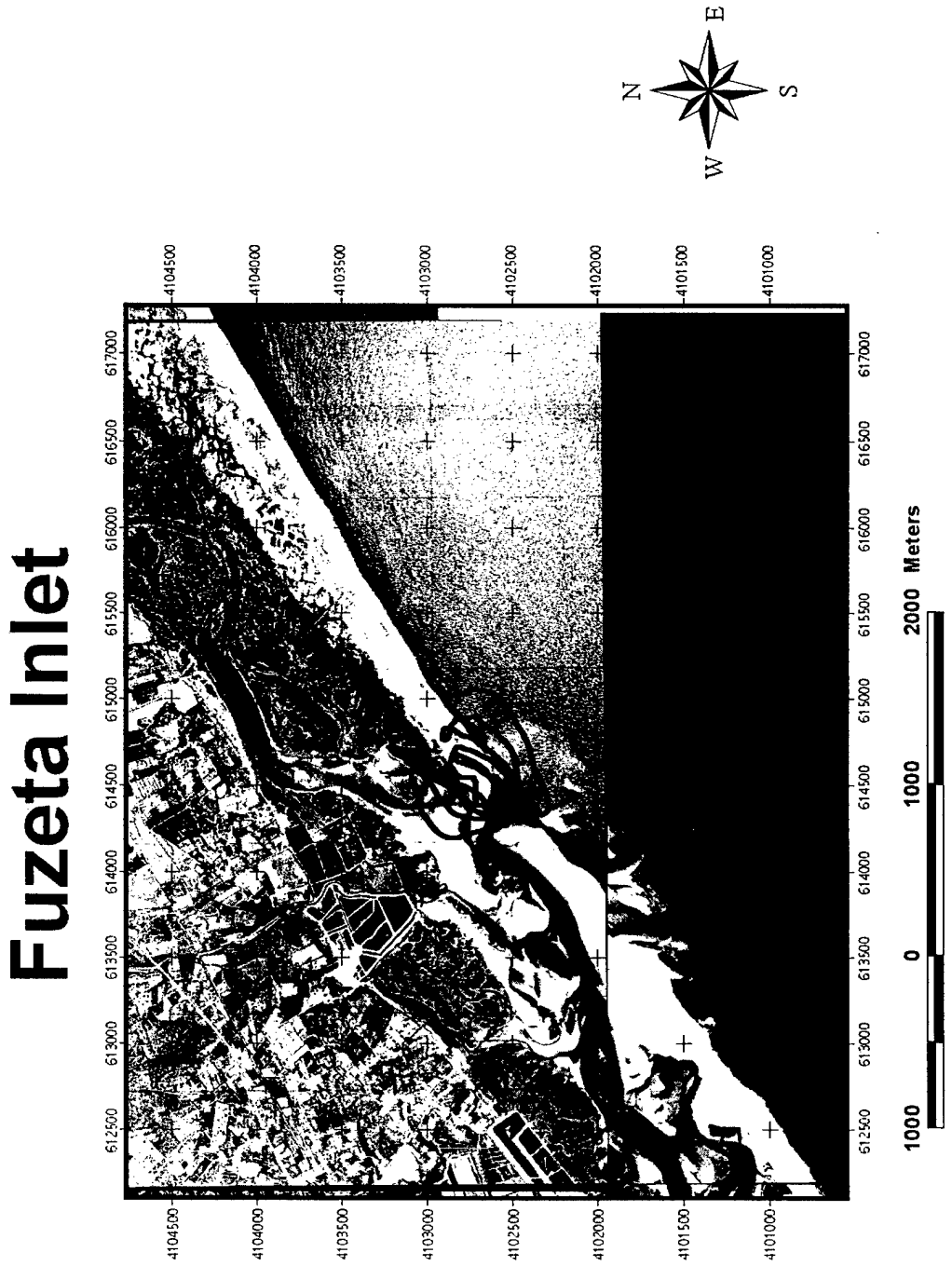


Figure A.5 Bathymetric Survey Coverage in the Fuzeta Inlet.

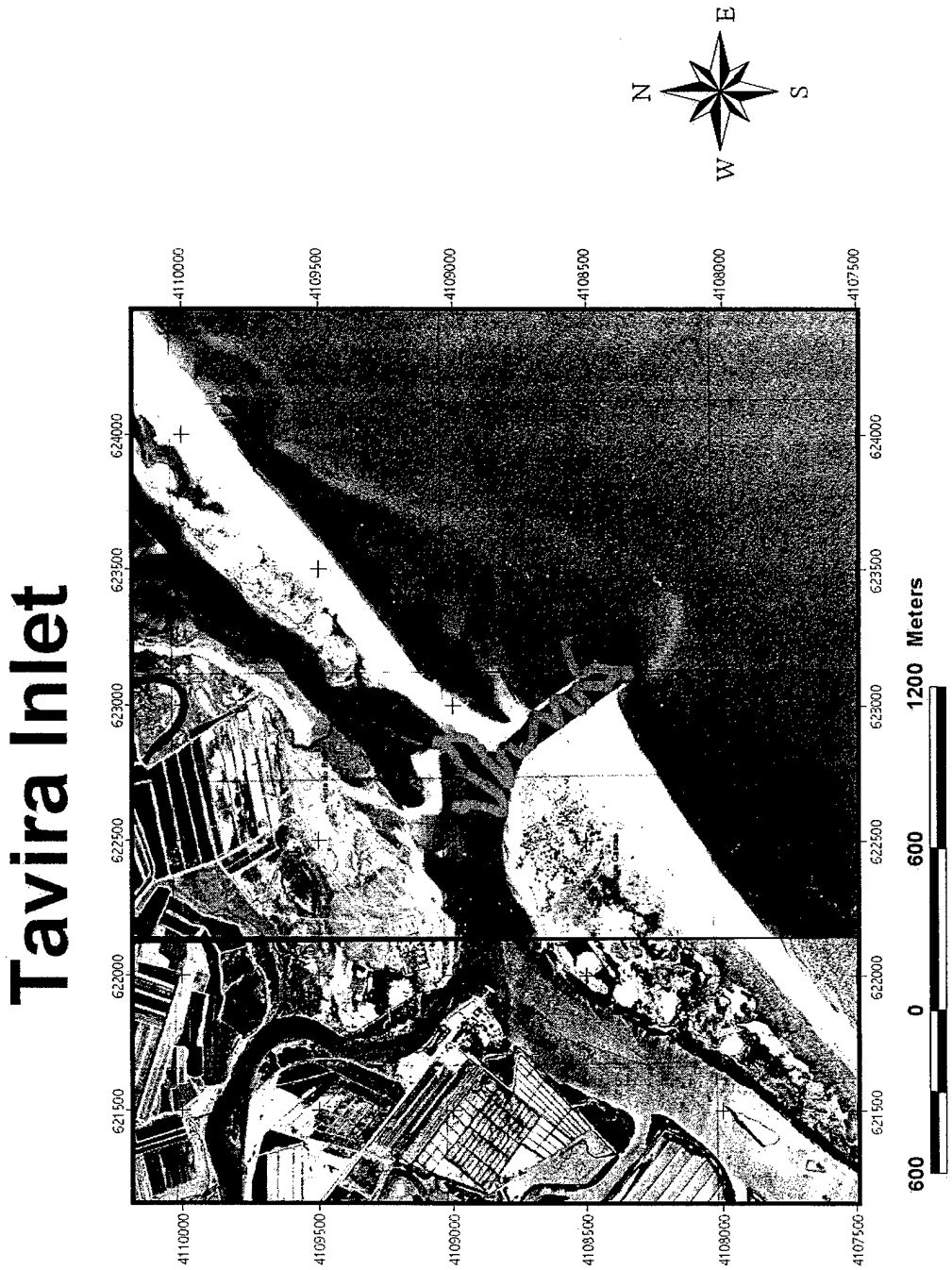


Figure A.6 Bathymetric Survey Coverage in the Tavira Inlet.

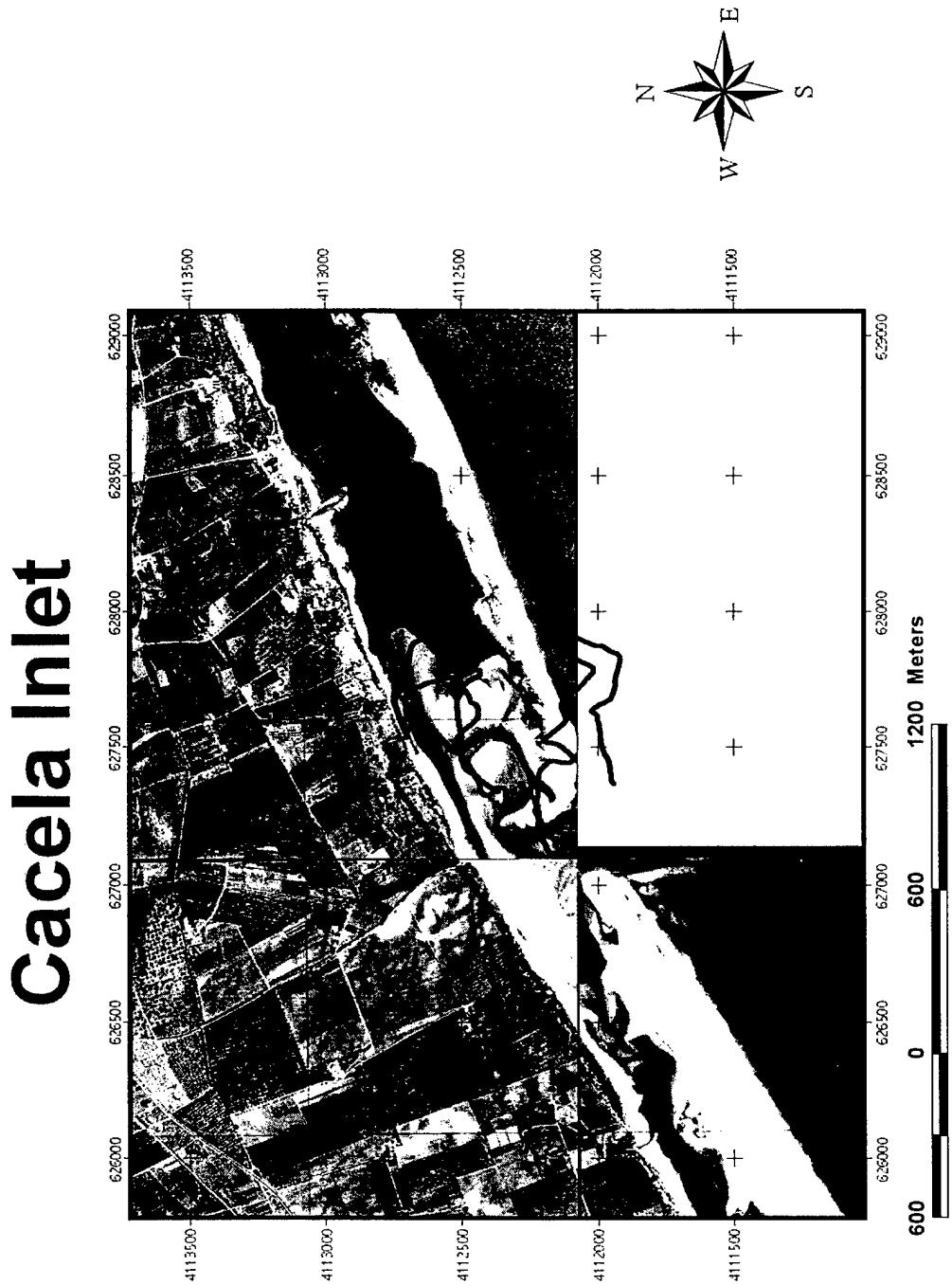


Figure A.7 Bathymetric Survey Coverage in the Cacela Inlet.

ANNEX B: ADV Deployment Characteristics and Data Output

B.1: ADV Deployment Setup Specifications

```
File ---------------------> c:\sontek\data\india004.ADR
FileSize (bytes) ----------> 3909463
Number of Bursts in File --> 1426
Time of first Burst -------> 1999/02/03  14:00:01
Time of last  Burst -------> 1999/02/13  11:24:01

ADV Hardware Configuration
---------------------------
SoftwareVerNum ------------> 6.7
Dsp SoftwareVerNum --------> 4.0
Electr. Board Rev. -------->
SerialNumber --------------> B126H
Probe type ----------------> OCEAN PROBE
Probe Orientation ---------> UP
CompassInstalled ----------> YES
RecorderInstalled ---------> YES
TempInstalled -------------> YES
PressInstalled ------------> YES
Pressure Scale ------------> 0.000675 dbar/count
Pressure Offset -----------> -1.392810 dbar
ExtSensorInstalled --------> NO
ParosSensorInstalled ------> NO
Transformation Matrix ----->   2.716   -1.355   -1.360
                ----->   0.008   2.369   -2.375
                ----->   0.344   0.345   0.345

ADV Deployment Setup
---------------------
DefaultTemp ----- (deg C) -> 15.00
DefaultSal ------ (ppt) ---> 35.00
DefaultSoundSpeed (m/s) ---> 1506.70
TempMode ------------------> MEASURED
VelRange Index ------------> 4
CoordSystem ---------------> ENU
OutFormat -----------------> BINARY

-------------------------Sampling 1-----Sampling 2-----Sampling 3
Number of Bursts ->          1188          238          0
SampRate - (Hz) -->          0.20          2.00         0.00
BurstInterval (s)->          720           3600         0
SamplesPerBurst -->          24            600          0
RecordAmpCorr ---->          YES           YES          YES
RecordCompass ---->          YES           YES          YES
RecordSensor ----->          YES           YES          YES
RecordStat ------->          YES           YES          YES
RecordExtSensor -->          NO            NO           NO
RecordParos ------>          NO            NO           NO
Bytes per Burst -->          626           13298        0
-----------------------------------------------------------------

DeploymentName ------------> INDIA
Comments: None
```

Figure B.1.1 ADV Deployment Setup Specifications.

B.2: Raw Data

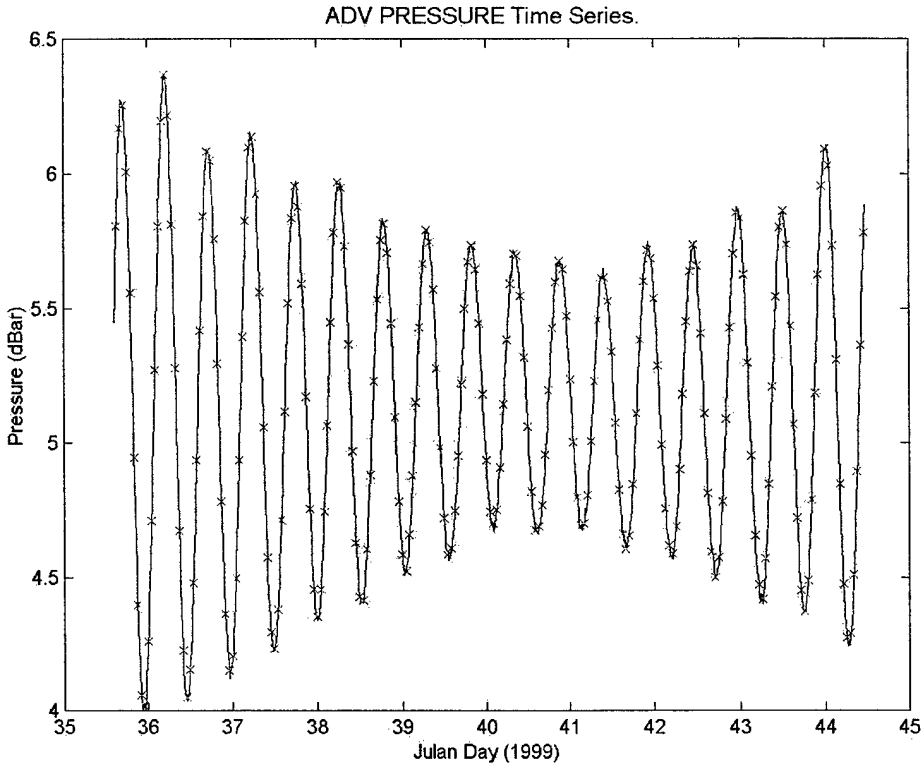


Figure B.2.1 ADV Pressure Data.

The previous figure shows the ADV-East (Cacela, offshore) pressure data. The line corresponds to "Sampling 1" (see table in Annex B.1) and the crosses correspond to "Sampling 2".

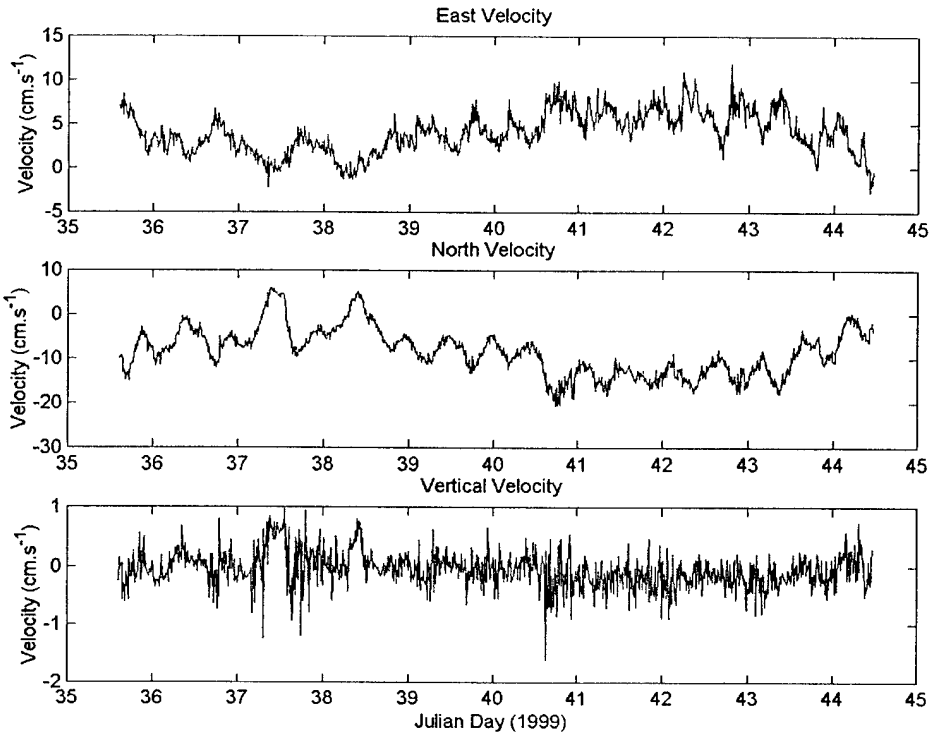


Figure B.2.2 ADV Velocity Data for "Sampling 1".

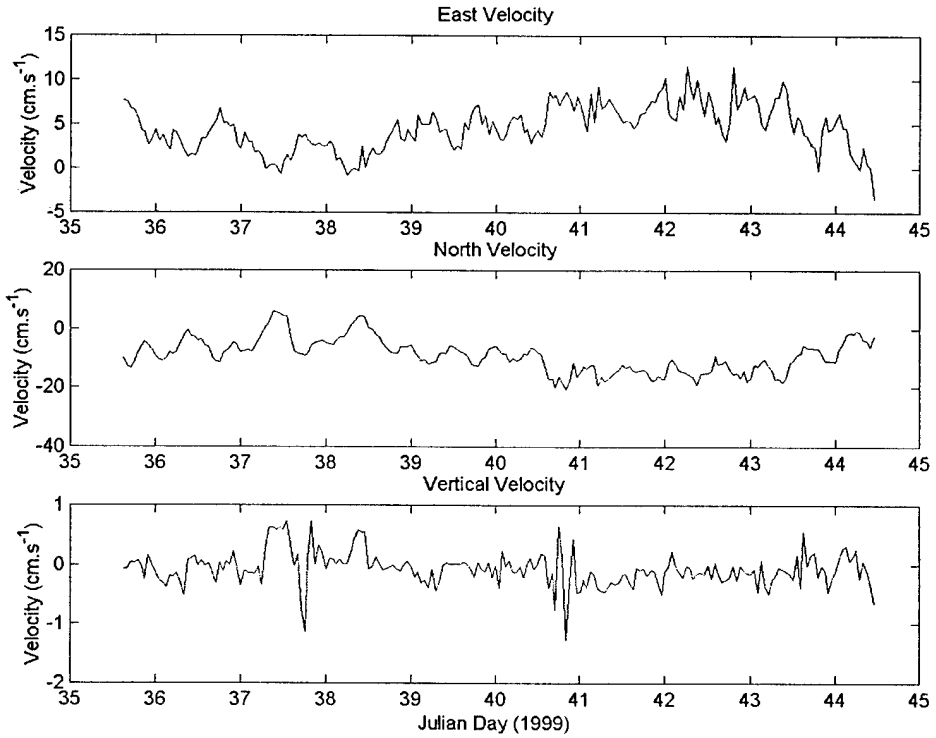


Figure B.2.3 ADV Velocity Data for "Sampling 2".

ANNEX C: ADCP Survey Characteristics and Sample Data Output

C.1: ADCP Survey and Instrument Deployment Locations.

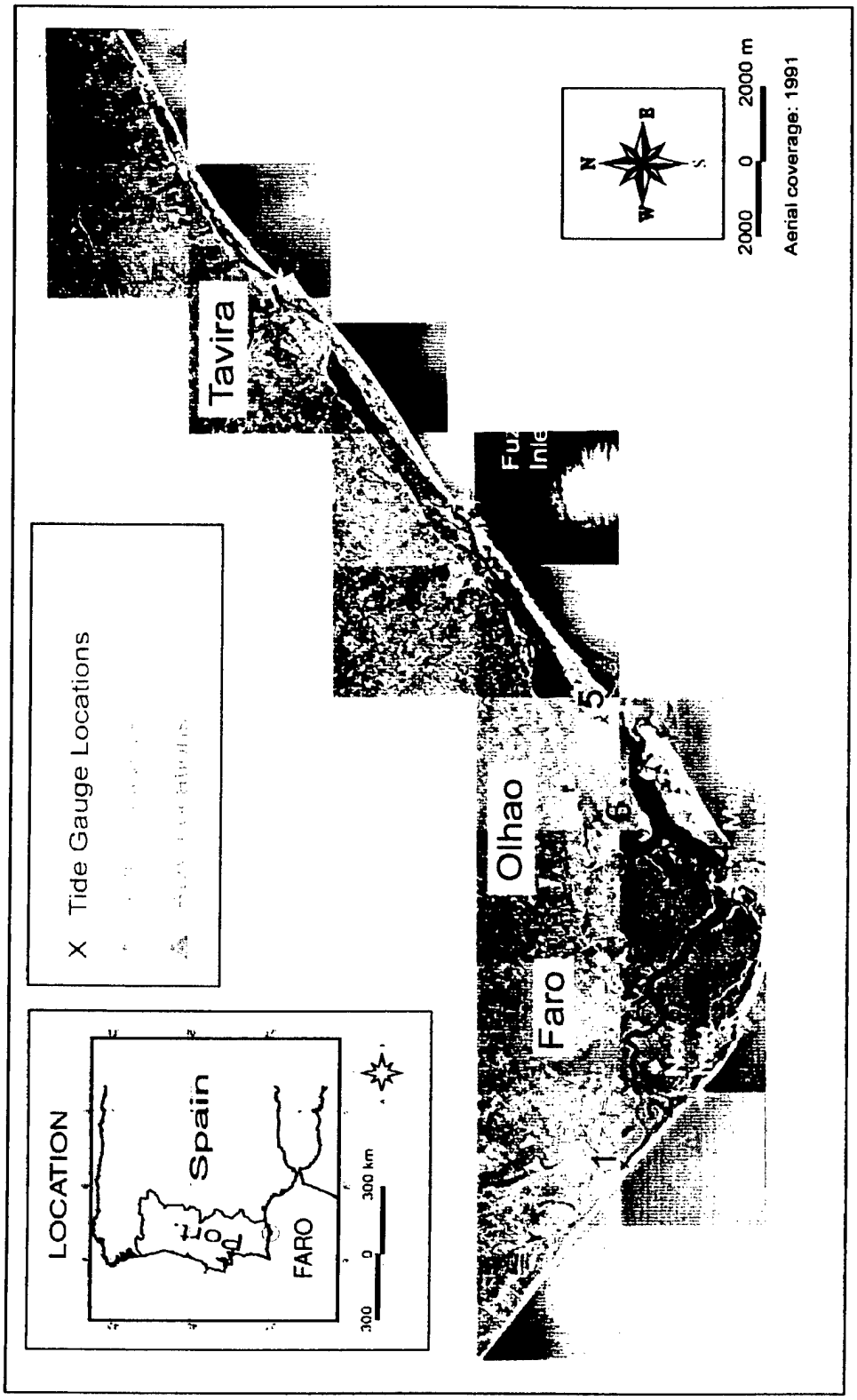


Figure C.1.1 Deployment and Survey Locations.

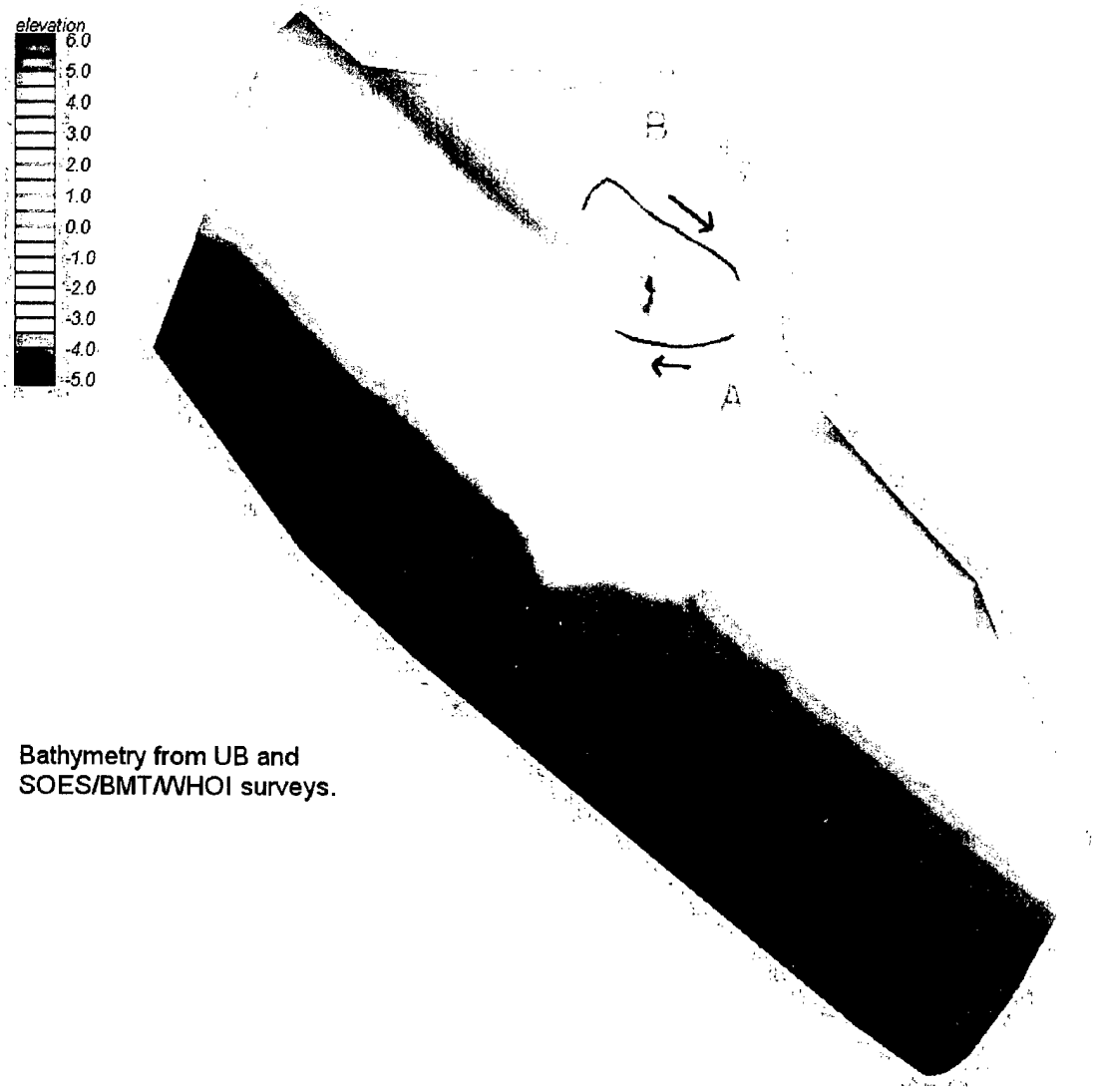
C.2 ADCP Instrument Configuration, Survey Lines and Selected ADCP Velocity Profiles

Figure C.2.1 ADCP Configuration File for the New Ancão Inlet Survey.

```
BEGIN RDI CONFIGURATION FILE
COMMUNICATIONS
{
ADCP          ( ON   COM1 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
ENSOUT        ( OFF  COM2 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
NAV           ( ON   COM2 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
REFOUT        ( OFF  COM4 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ]
EXTERNAL      ( OFF  COM4 9600 N 8 1 ) [ Port Baud Parity Databits Stopbits ] }
ENSEMBLE OUT
{
ENS CHOICE    ( N N N N N N N N )  [ Vel Corr Int %Gd Status Leader BTrack Nav ]
ENS OPTIONS   (  NONE   1   3   1   3 )  [ Ref First Last Start End ]
ENS TYPE      (  RAW )  [ RAW (default) or AVERAGED data transmitted ] }
ADCP HARDWARE
{
Firmware        ( 8.25 )
Angle           (      20 )
Frequency       (    1200 )
System          (   EARTH )
Mode            (       1 )
Orientation     (    DOWN )
Pattern         (  CONVEX ) }
DIRECT COMMANDS
{
WS25
WF44
BX100
WN032
WD111100000
WP00010
BP008
WM4
TP000010
WV352
EX11111 }
RECORDING
{
Deployment ( NEWI )
Drive 1    (   C  )
Drive 2    (   C  )
ADCP       ( YES )
Average    ( YES )
Navigation ( YES ) }
CALIBRATION
{
ADCP depth                  (    0.40 m       )
Heading / Magnetic offset   (   0.00     -5.50 deg )
Transducer misalignment     (    0.00 deg     )
Intensity scale             (    0.43 dB/cts )
Absorption                  (   0.470 dB/m    )
Salinity                    (    35.0 ppt     )
Speed of sound correction   (     YES         )
Pitch & roll compensation   (     YES         )
Tilt Misalignment           (    0.00 deg     )
Pitch_Offset                (    0.000 deg     )
Roll_Offset                 (    0.000 deg     )
Top discharge estimate      (    CONSTANT     )
Bottom discharge estimate   (     POWER       )
Power curve exponent        (      0.1667    )
Edge_slope coefficient      ( -1.00000 ) [-1=Trianglar(0.3535):-2=Square(0.91):User] }
```

ADCP Configuration File for the New Ancão Inlet Survey (Cont.).

```
PROCESSING
{
Average every ( 0.00 s )
Depth sounder (  NO )
MaxFileSize ( 1200 )
Refout_info (   1   8  30.00  1.000 0      1) [bins:1st last, limit, weight, format,
delaysec]
External_formats  ( N N N N N )  [ HDT HDG RDID RDIE ]
External_decode   ( N N N N ) [ heading pitch roll temp ]
Start_Shore_distance  ( 1500 ) [ cm ]
End_Shore_distance    ( 1000 ) [ cm ]
Edge_distance_prompt  ( YES )
}
GRAPHICS
{
Units        ( SI )
Velocity Reference (   BOTTOM   )
East_Velocity      ( -300.0  300.0  cm/s )
North_Velocity     ( -300.0  300.0  cm/s )
Vert_Velocity      (  -30.0   30.0  cm/s )
Error_Velocity     (  -10.0   10.0  cm/s )
Depth              (      1     28   bin )
Intensity          (      0    200     dB)
Discharge          (  -1000   1000  m3/s )
East_Track         (  -1523   1464     m )
North_Track        (  -1536   1451     m )
Ship track         (  1 bin  100.0  cm/s )
Proj_Velocity      ( -100.0  100.0  cm/s )
Proj_Angle         (    0.0  deg from N )
Bad_Below_Bottom   (   NO  )
Line1              (                                                )
Line2              (                                                )
}
HISTORY
{
SOFTWARE       ( BB-TRANSECT )
Version        ( 2.80 )
}
END RDI CONFIGURATION FILE
```



Bathymetry from UB and SOES/BMT/WHOI surveys.

Figure C.2.2 New Ancão Inlet ADCP Survey Transects.

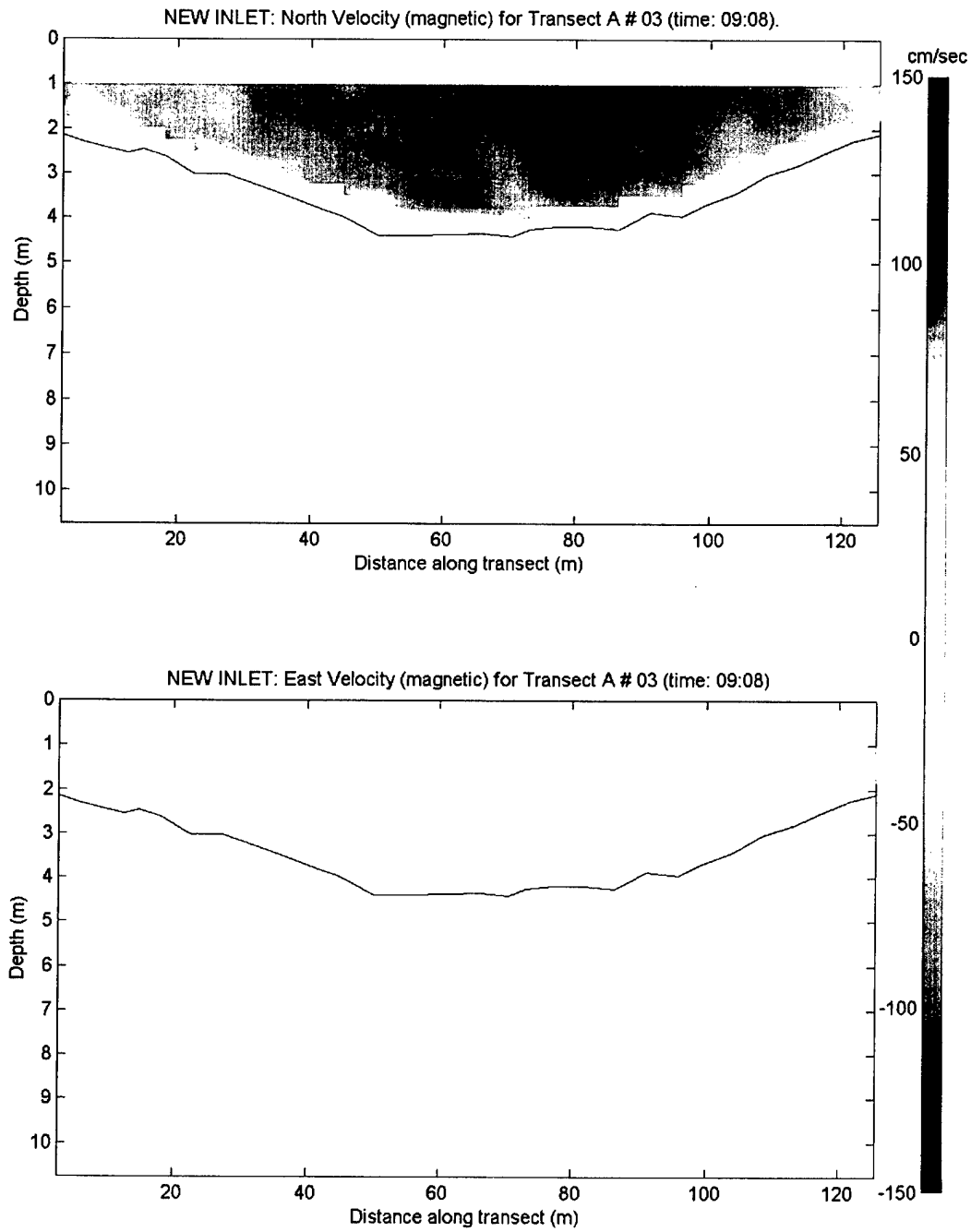


Figure C.2.3 Selected Velocity Profile, Transect A, New Ancão Inlet.

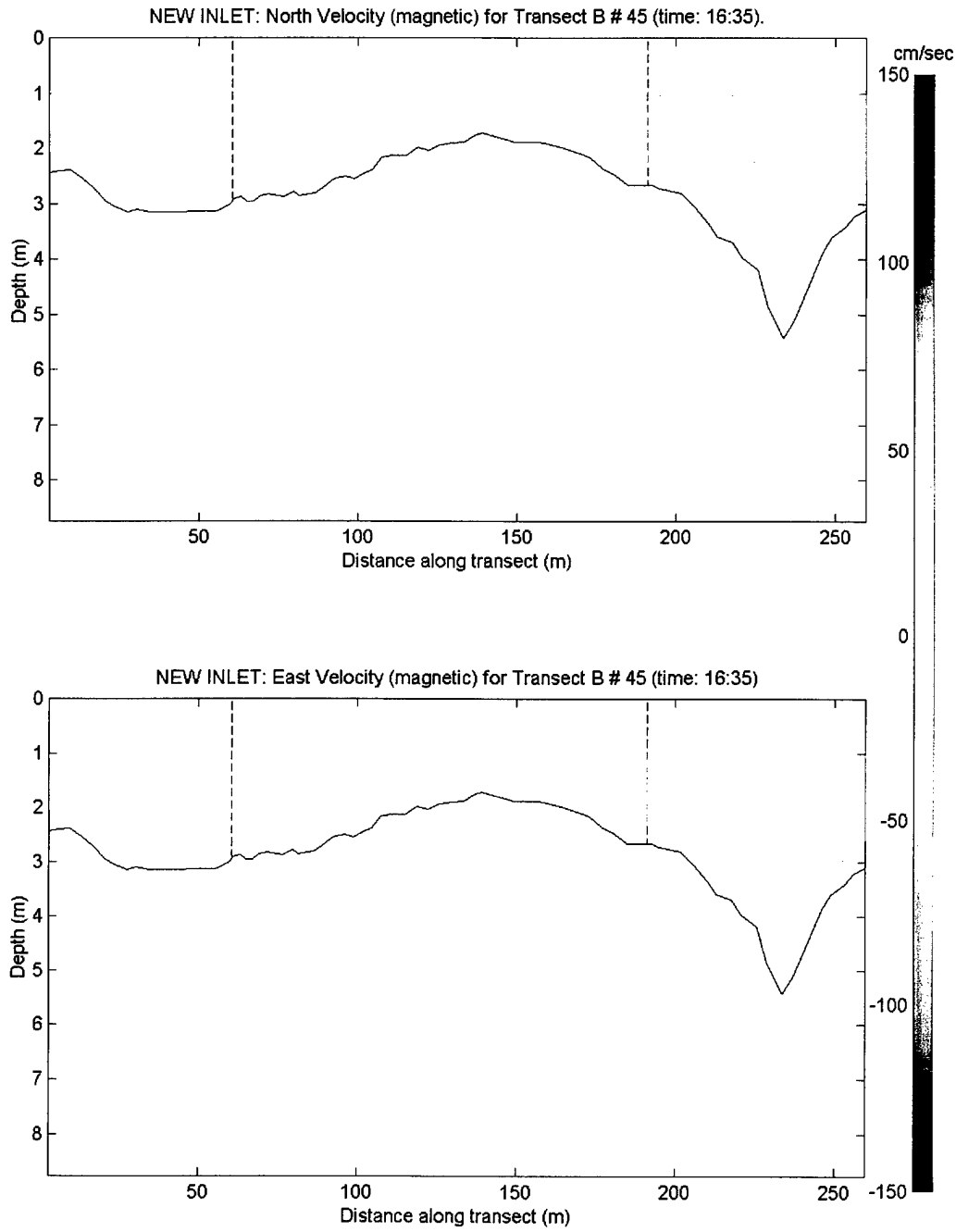


Figure C.2.4 Selected Velocity Profile, Transect B, New Ancão Inlet.

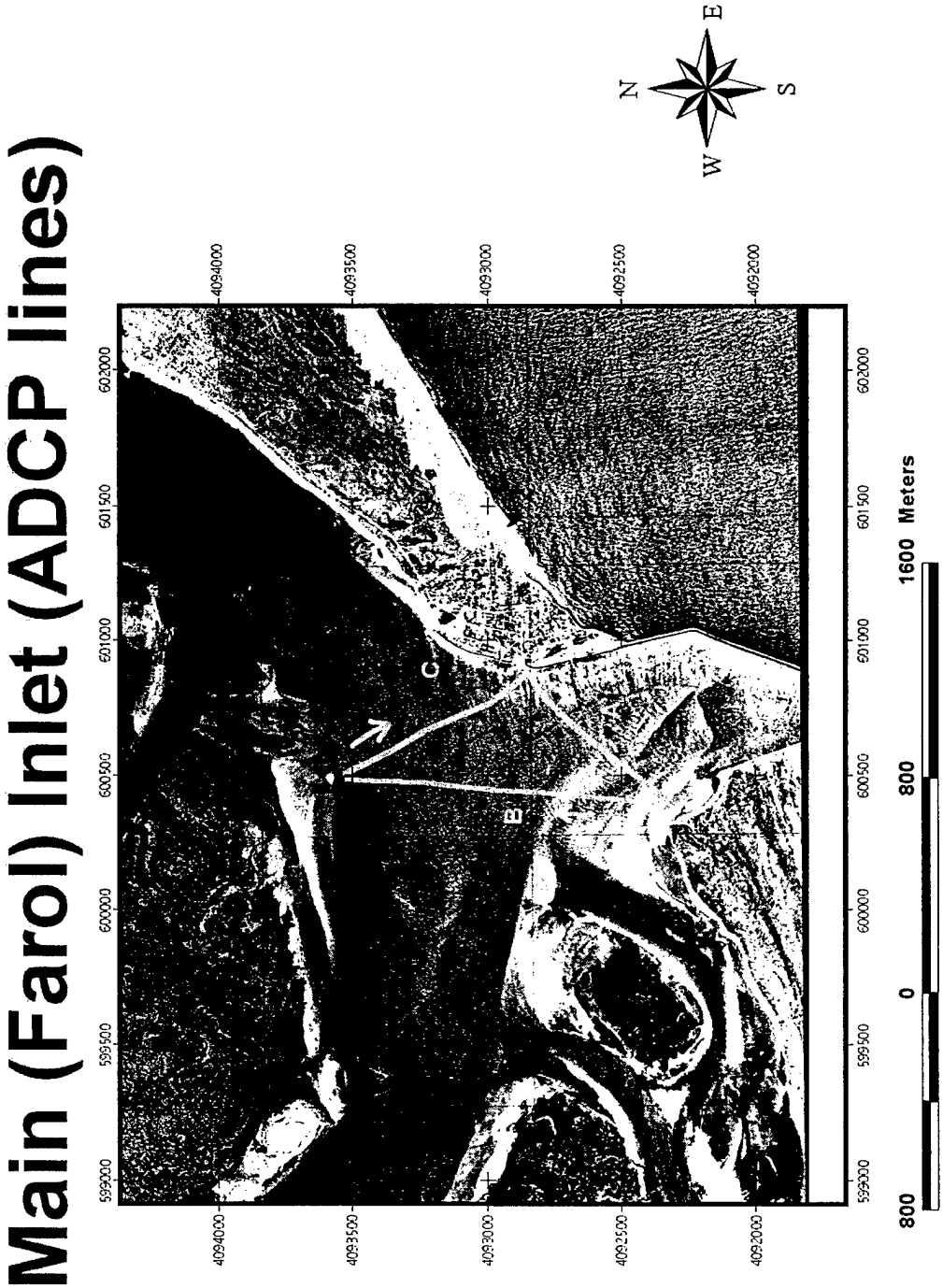


Figure C.2.5 Main Inlet ADCP Survey Transects.

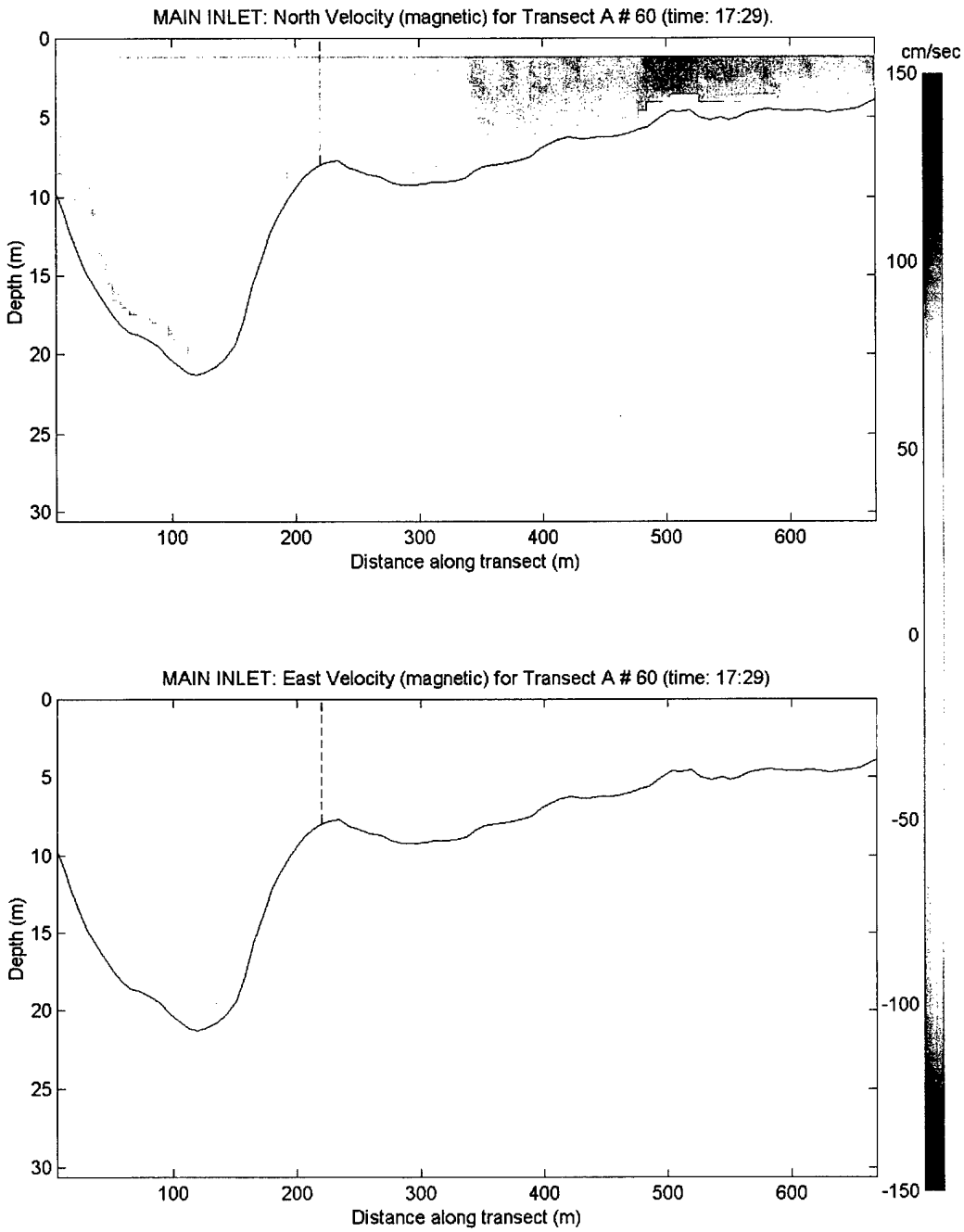


Figure C.2.6 Selected Velocity Profile, Transect A, Main Inlet.

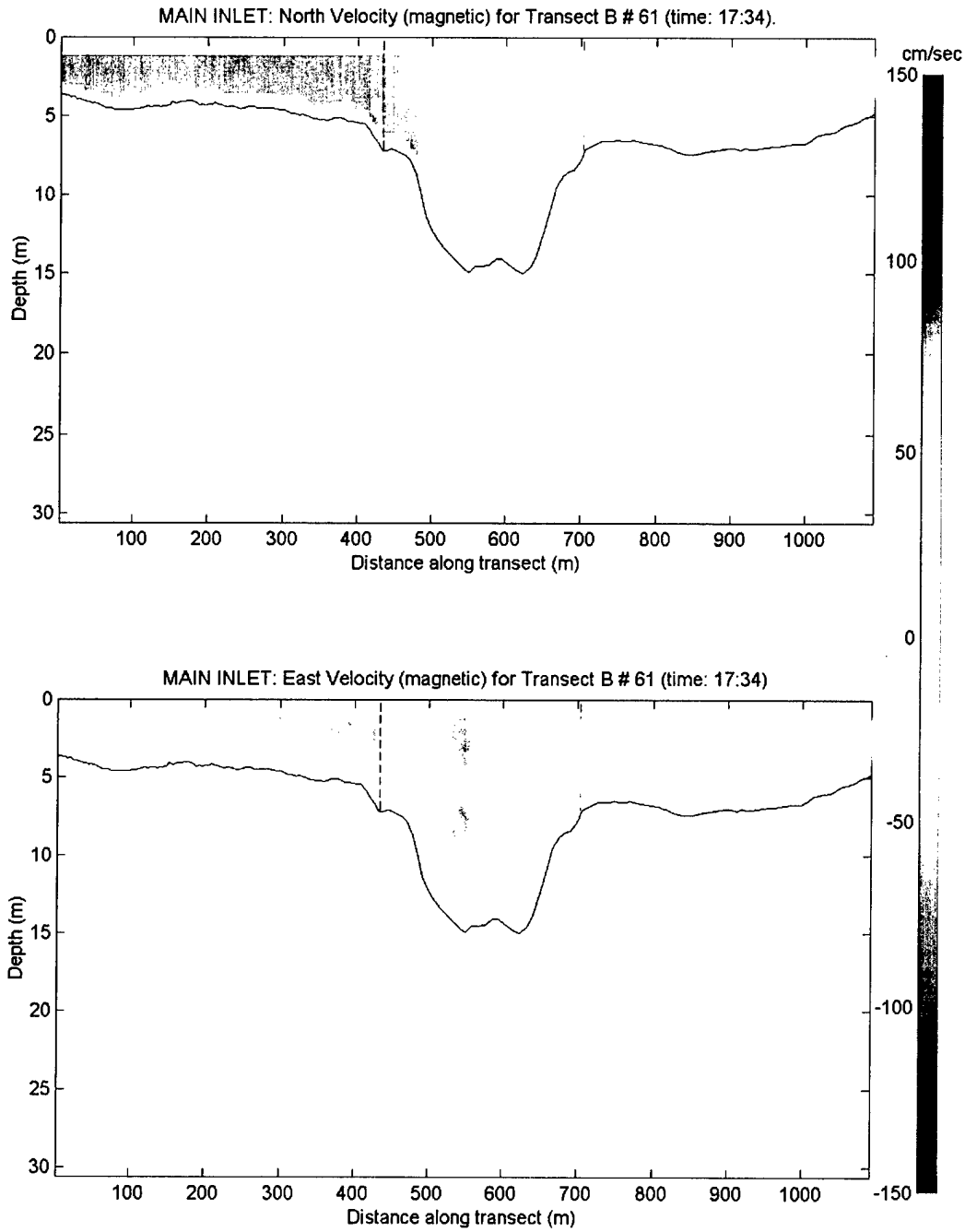


Figure C.2.7 Selected Velocity Profile, Transect B, Main Inlet.

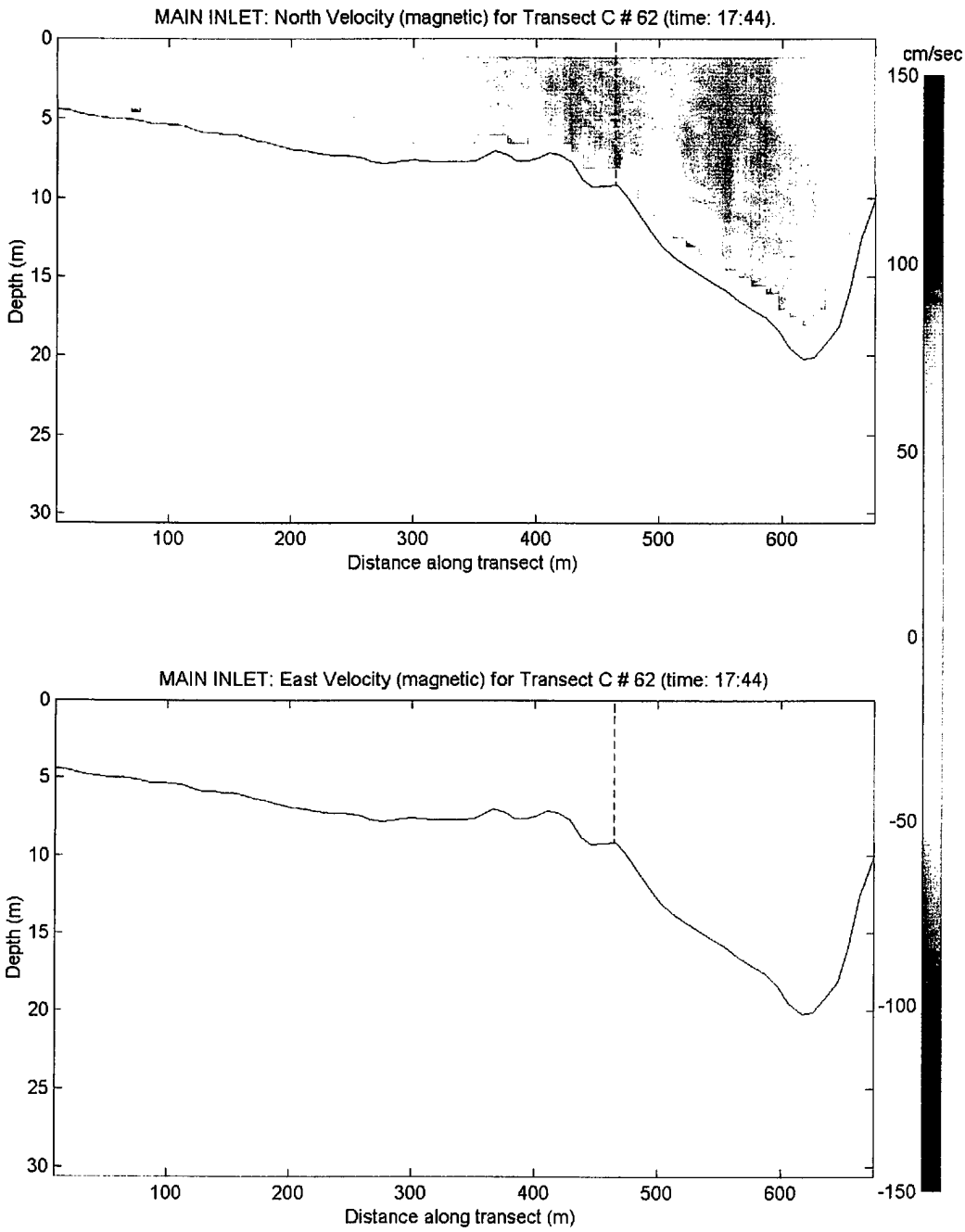


Figure C.2.8 Selected Velocity Profile, Transect C, Main Inlet.

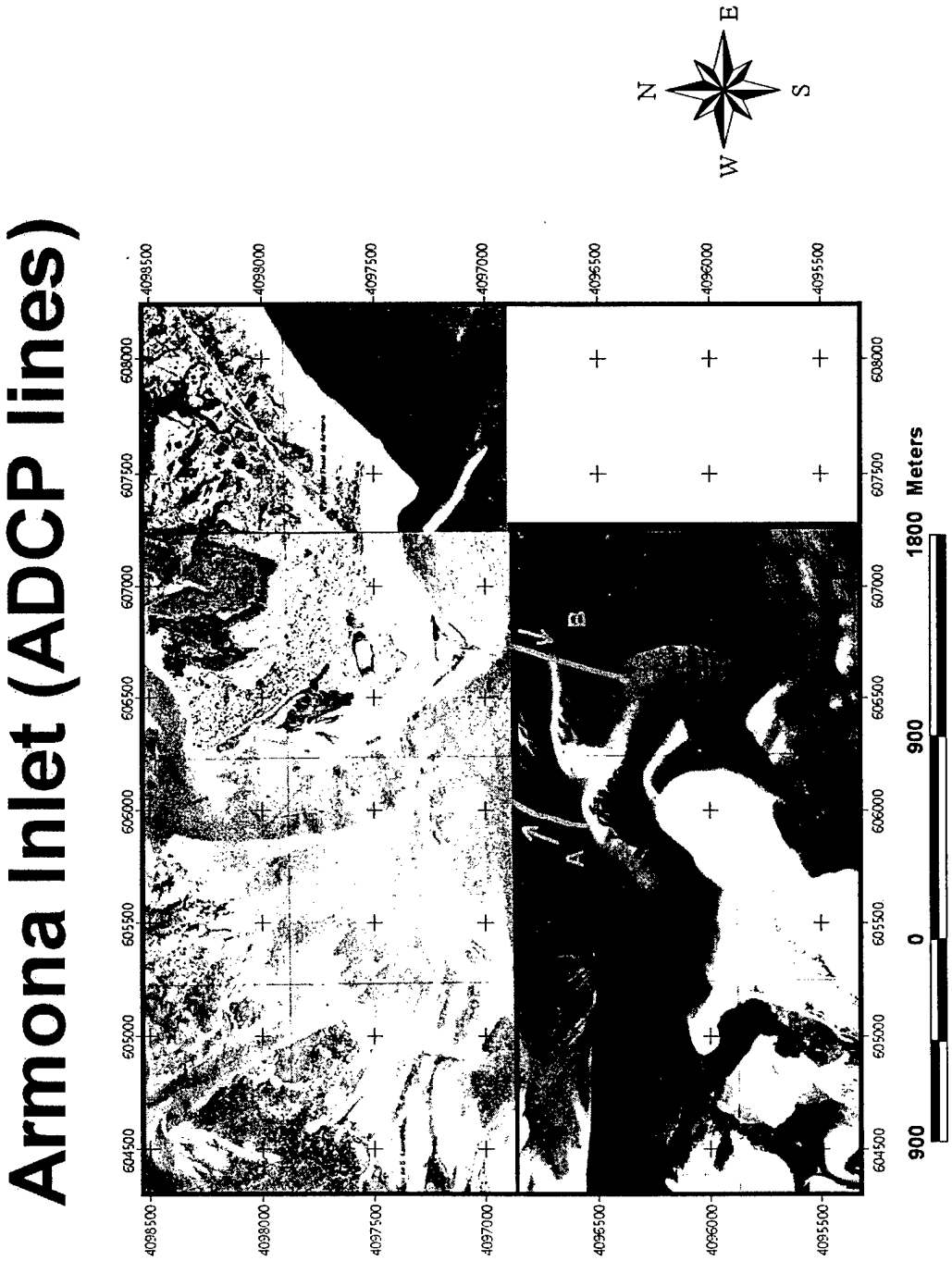


Figure C.2.9 Armona Inlet ADCP Survey Transects.

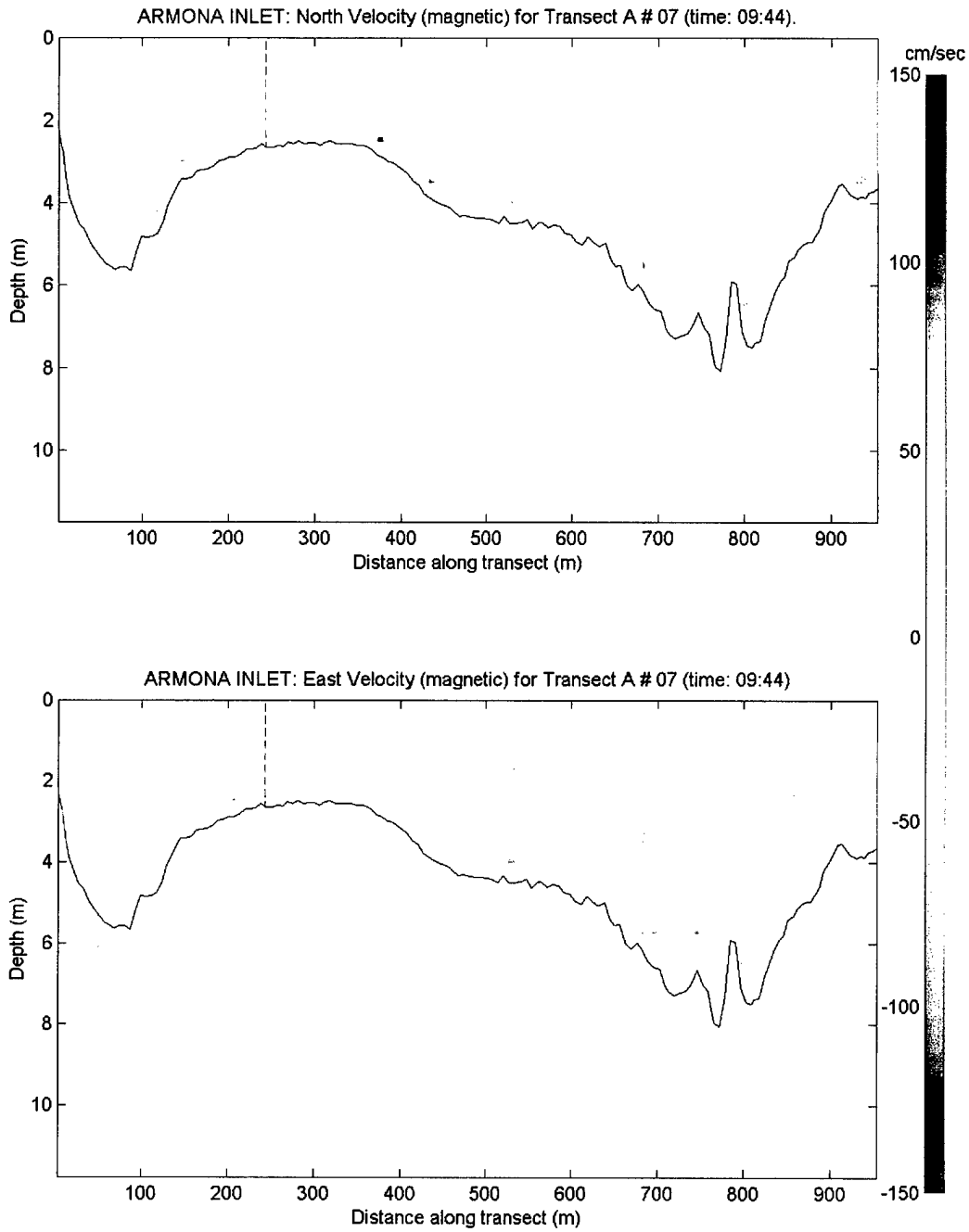


Figure C.2.10 Selected Velocity Profile, Transect A, Armona Inlet.

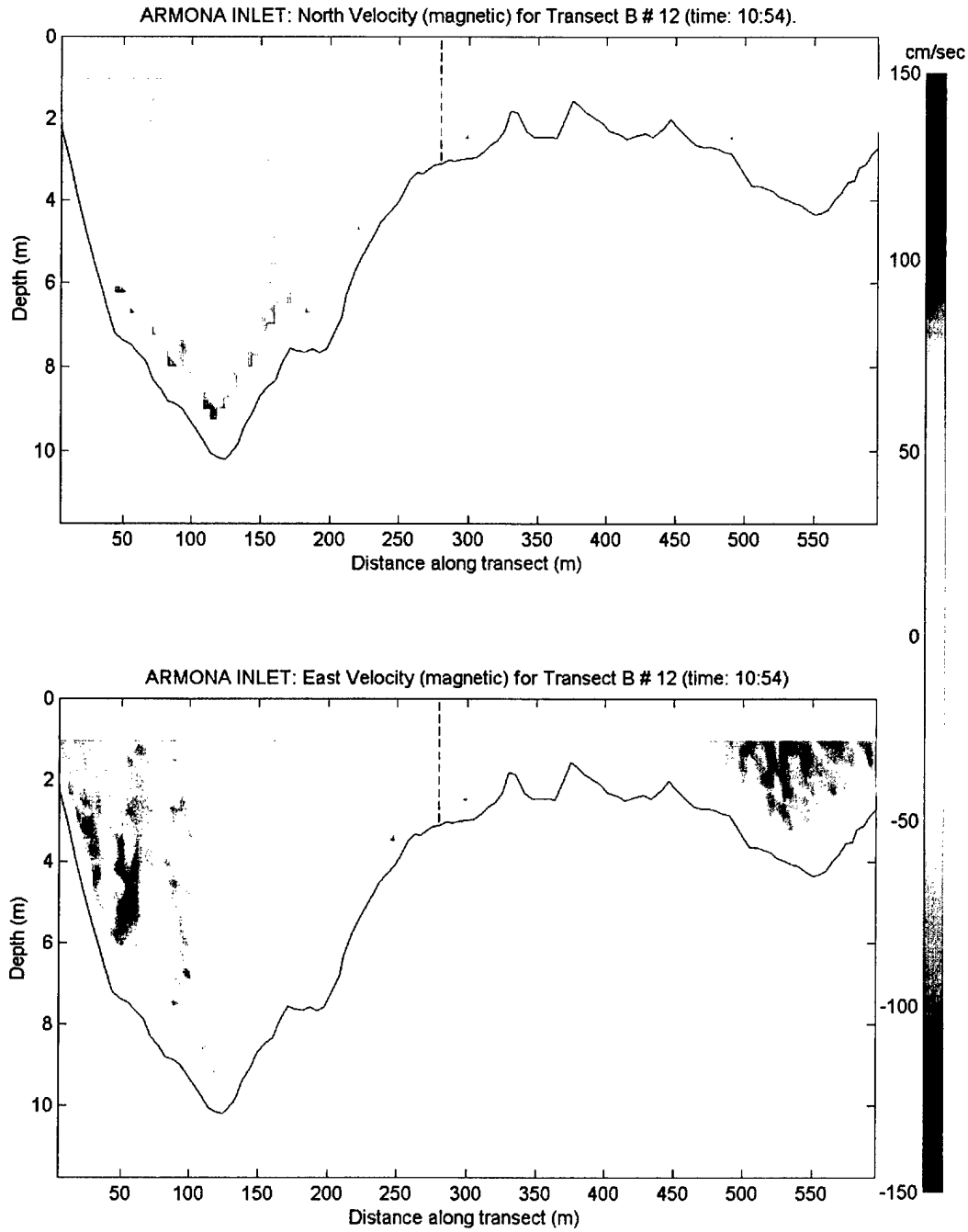


Figure C.2.11 Selected Velocity Profile, Transect B, Armona Inlet.

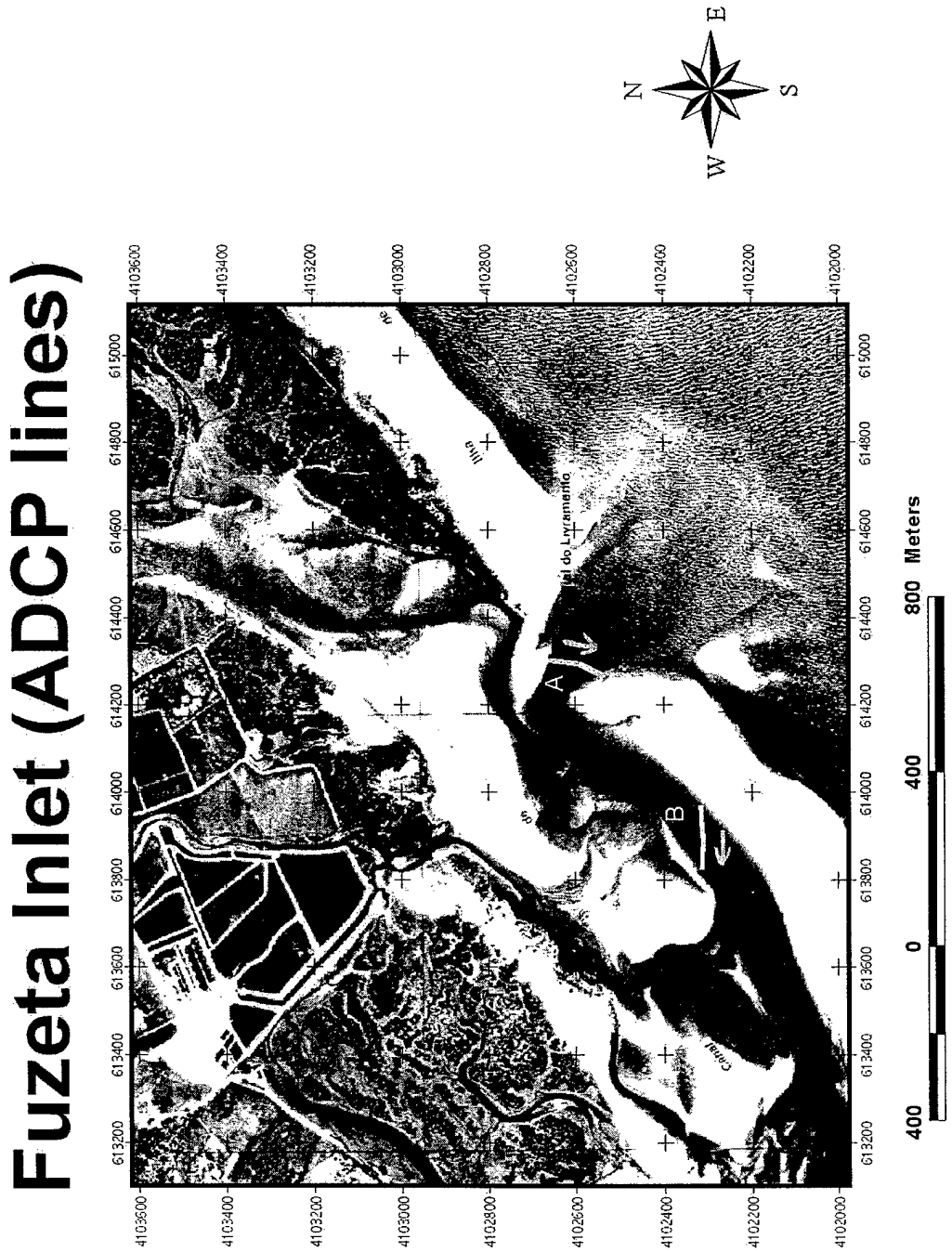


Figure C.2.12 Fuzeta Inlet ADCP Survey Transects.

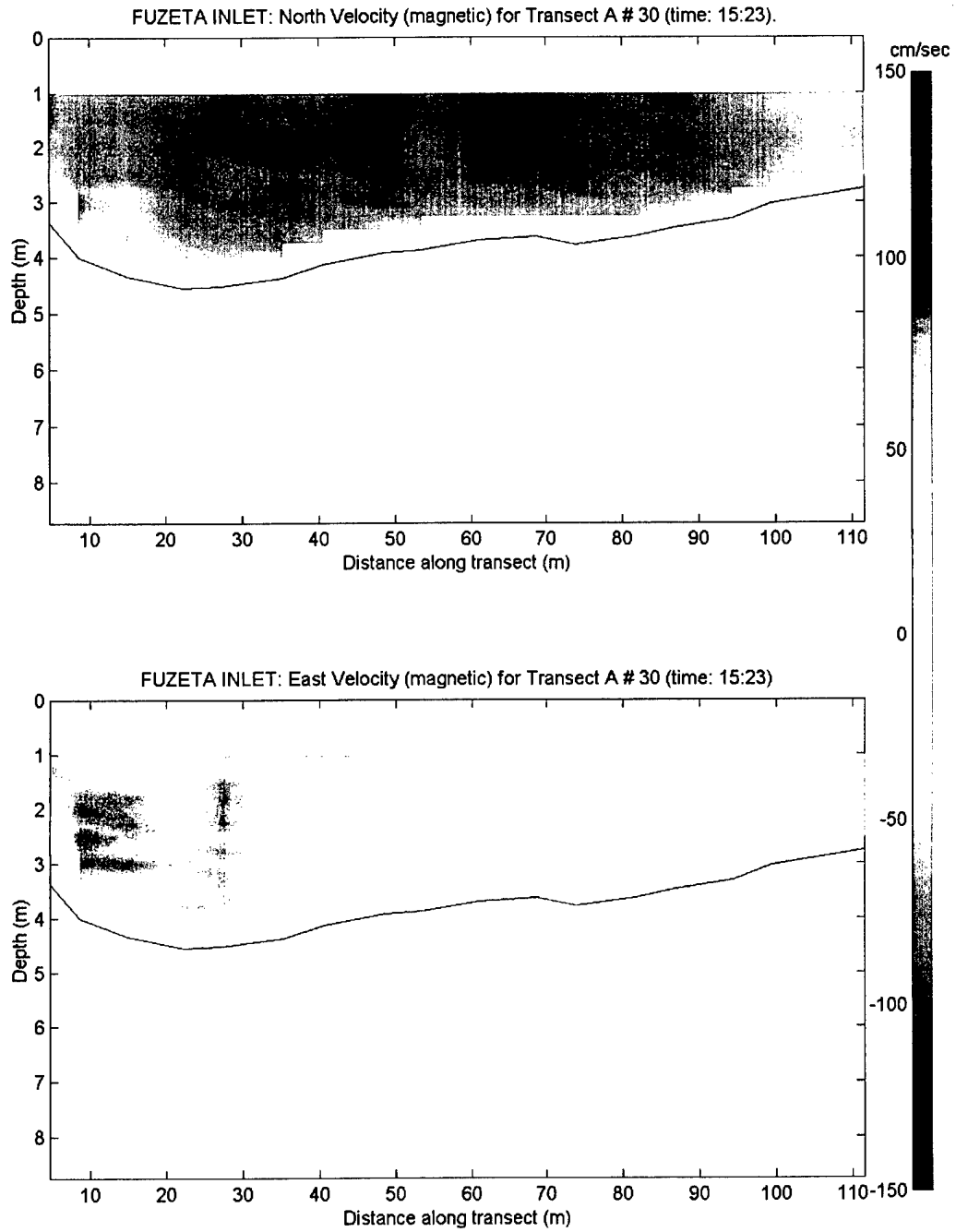


Figure C.2.13 Selected Velocity Profile, Transect A, Fuzeta Inlet.

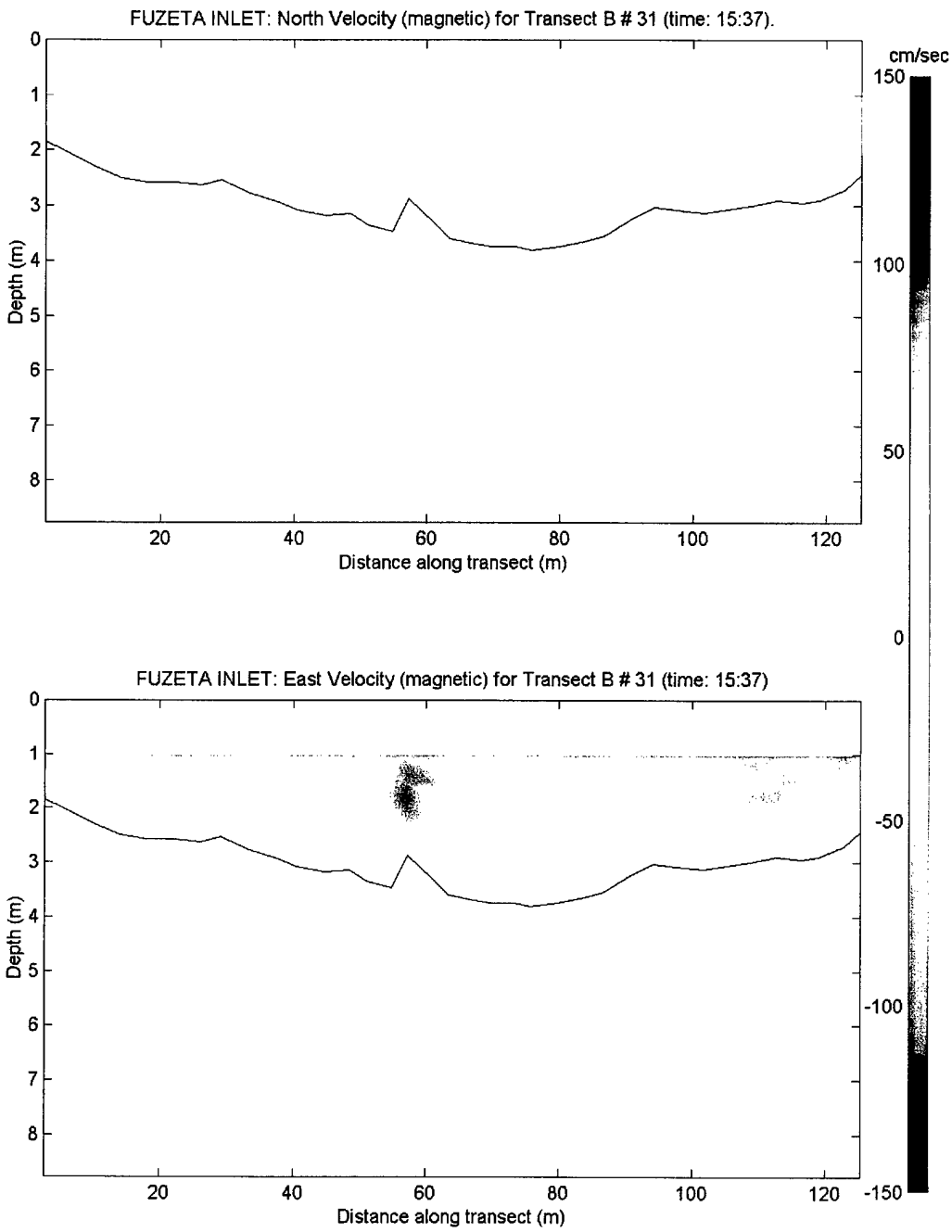


Figure C.2.14 Selected Velocity Profile, Transect B, Fuzeta Inlet.

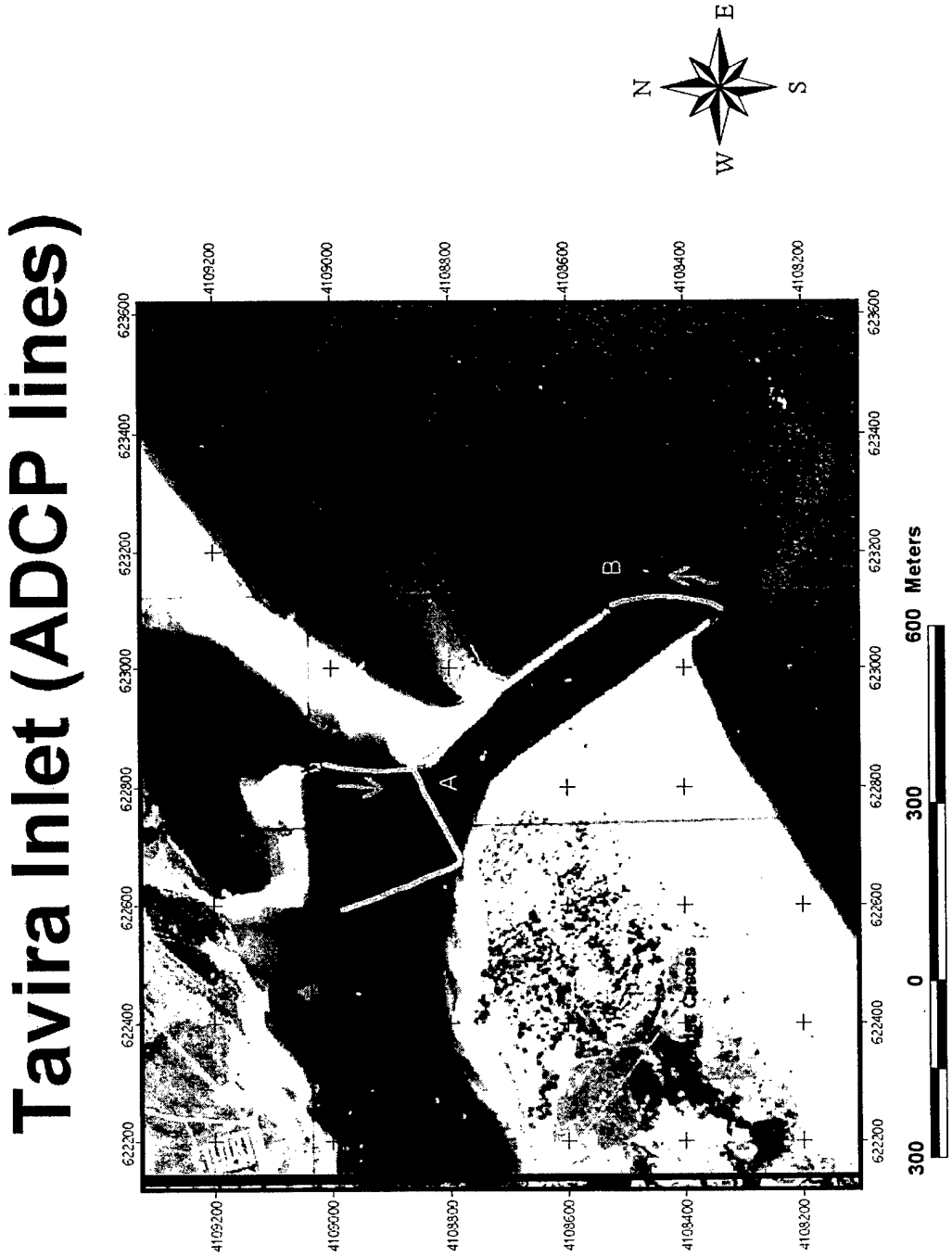


Figure C.2.15 Tavira Inlet ADCP Survey Transects.

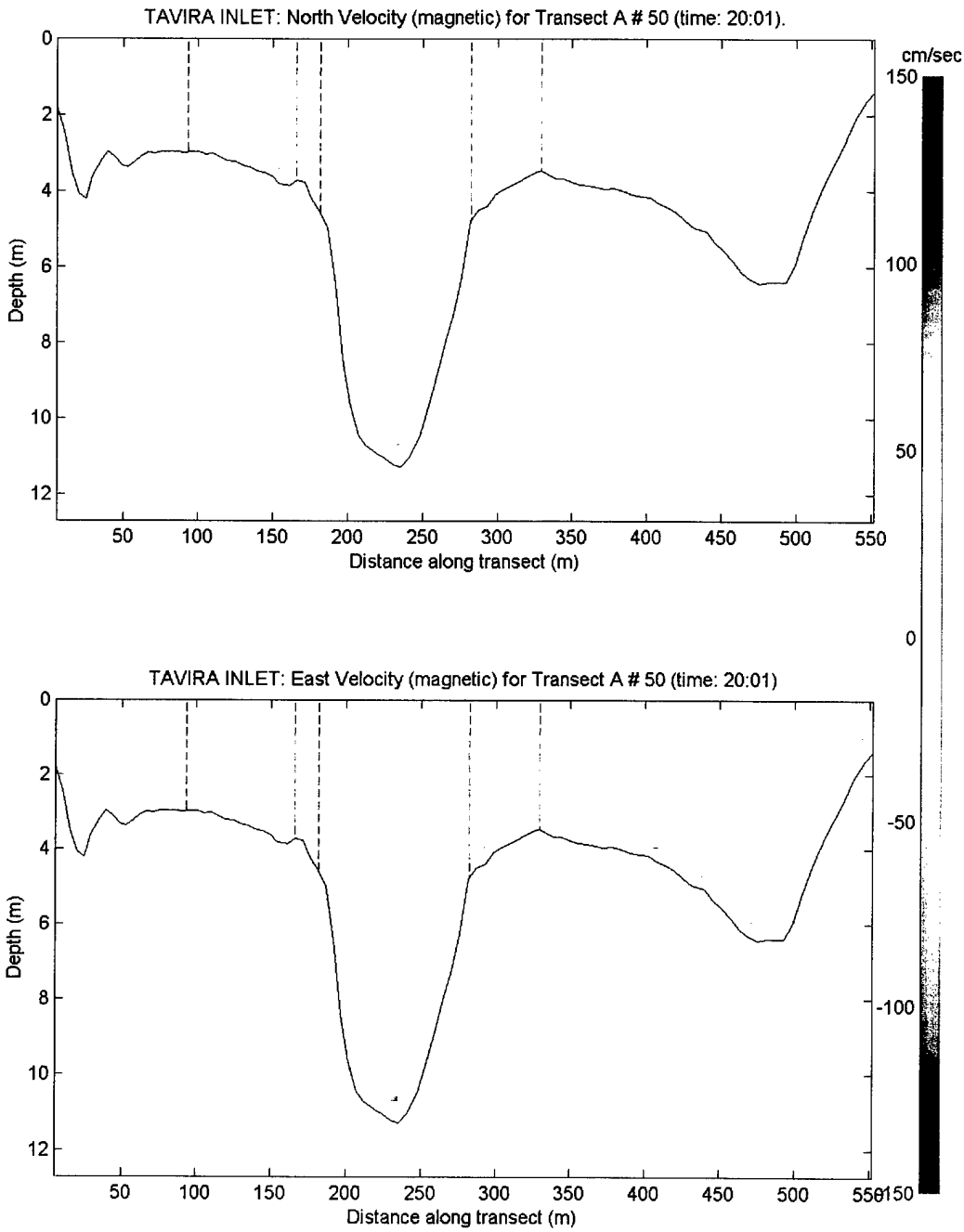


Figure C.2.16 Selected Velocity Profile, Transect A, Tavira Inlet.

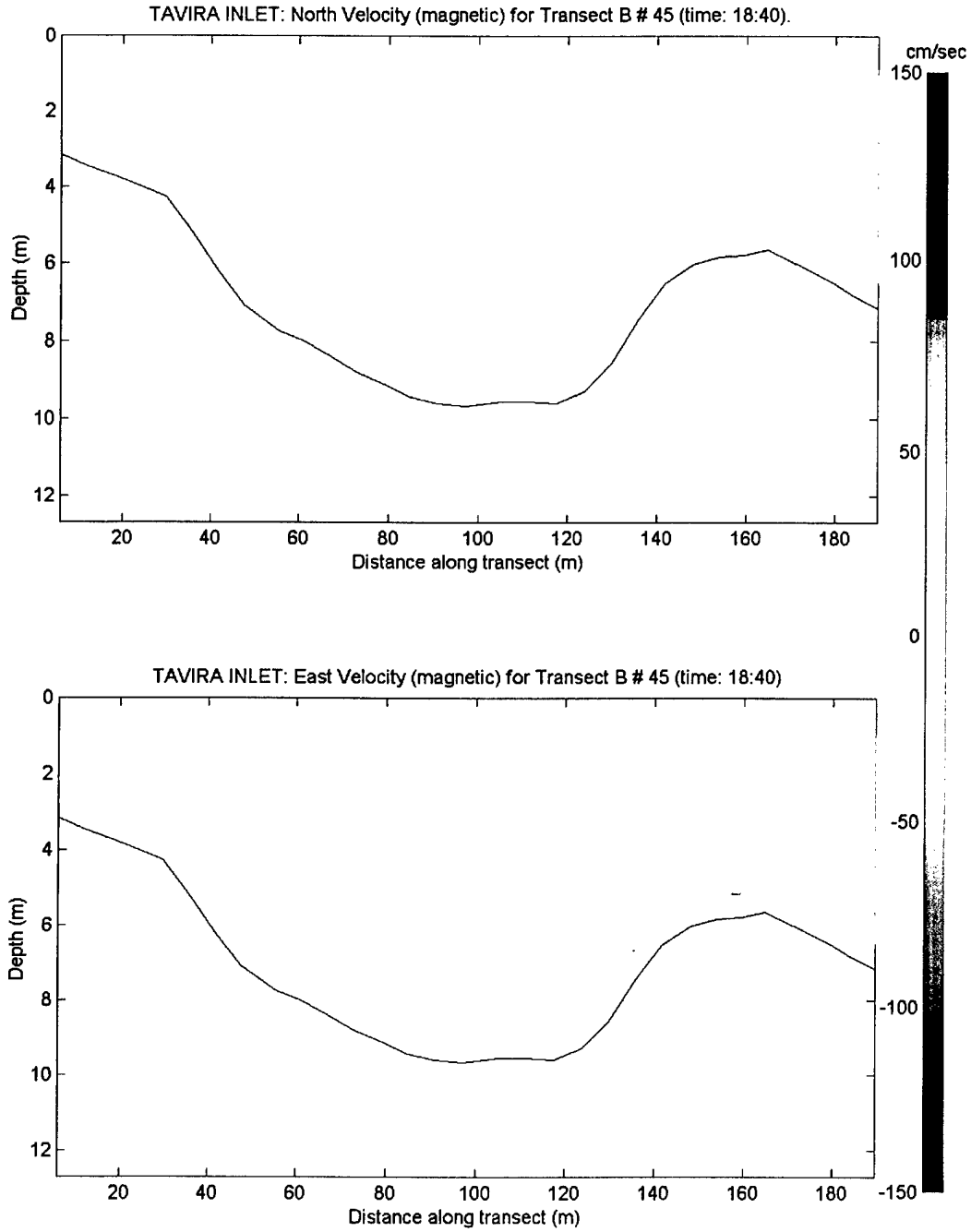


Figure C.2.17 Selected Velocity Profile, Transect B, Tavira Inlet.

Note: Given the lack of recent bathymetry and the mobility of the inlet (as shown in Figure A.6), the production of a figure with the actual location of the transect superimposed to a image of the site was not possible.

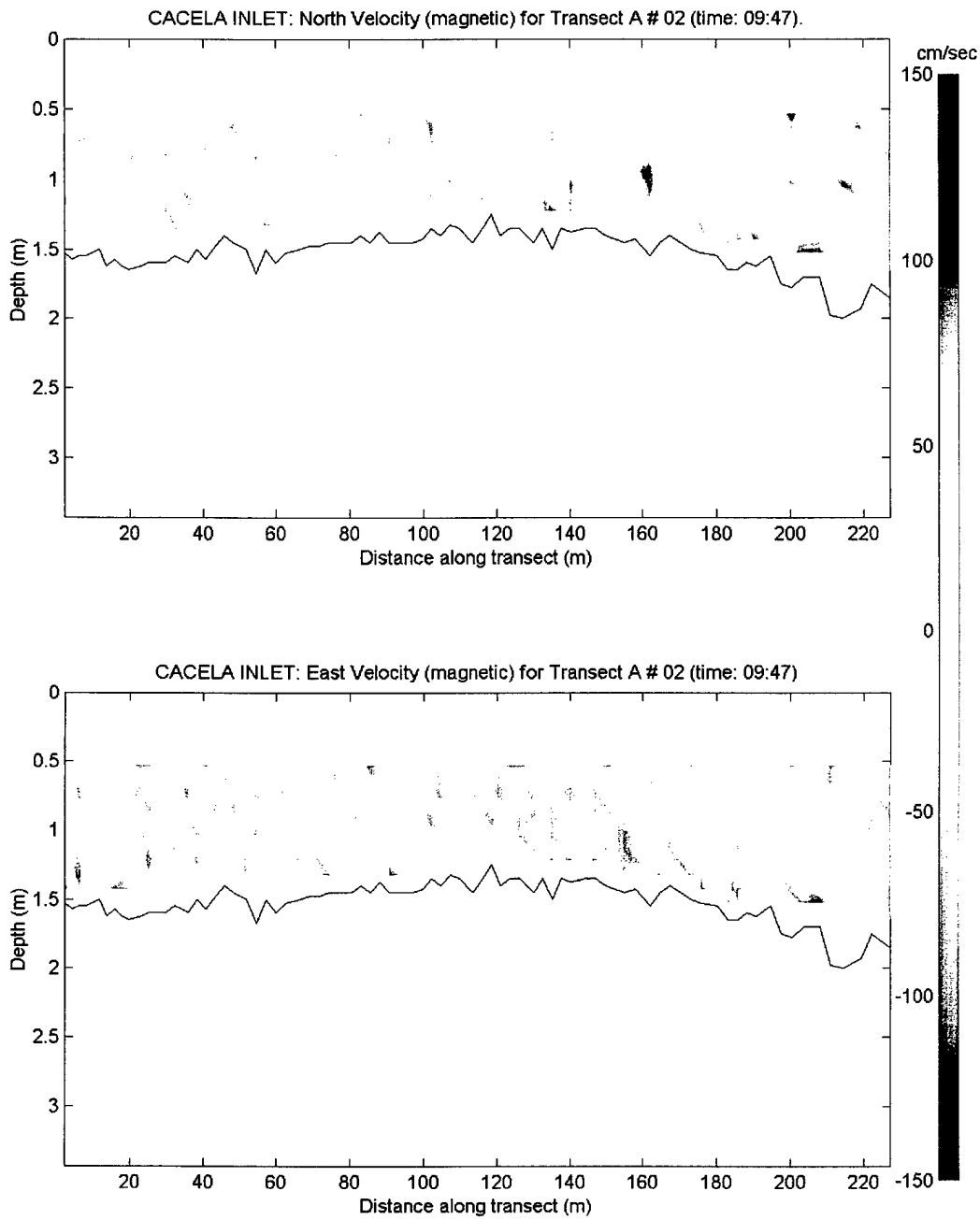
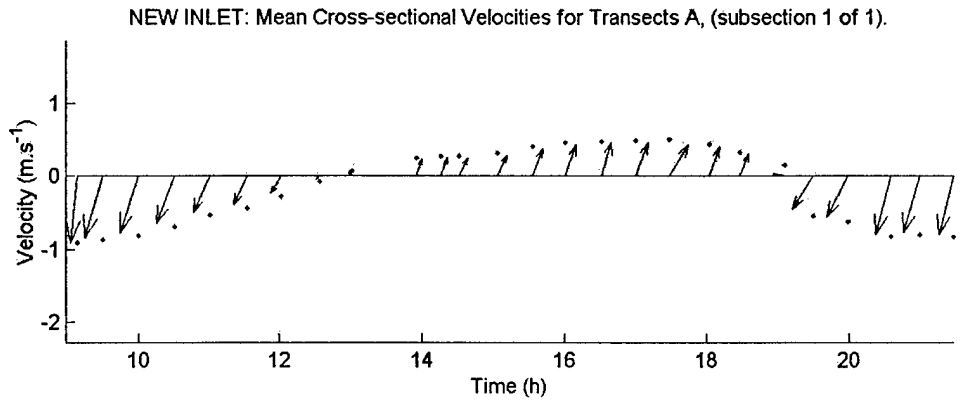


Figure C.2.18 Selected Velocity Profile, Transect A, Cacela Inlet.

C.3: ADCP Discharge Computations



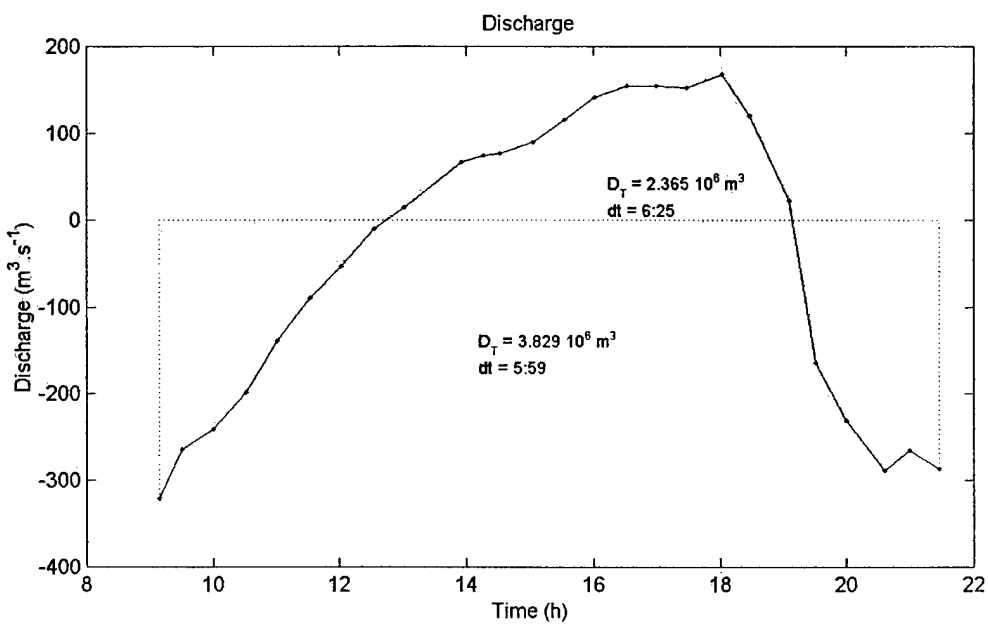


Figure C.3.1 Transect A (1/1) Velocity and Discharge, New Ancão Inlet.

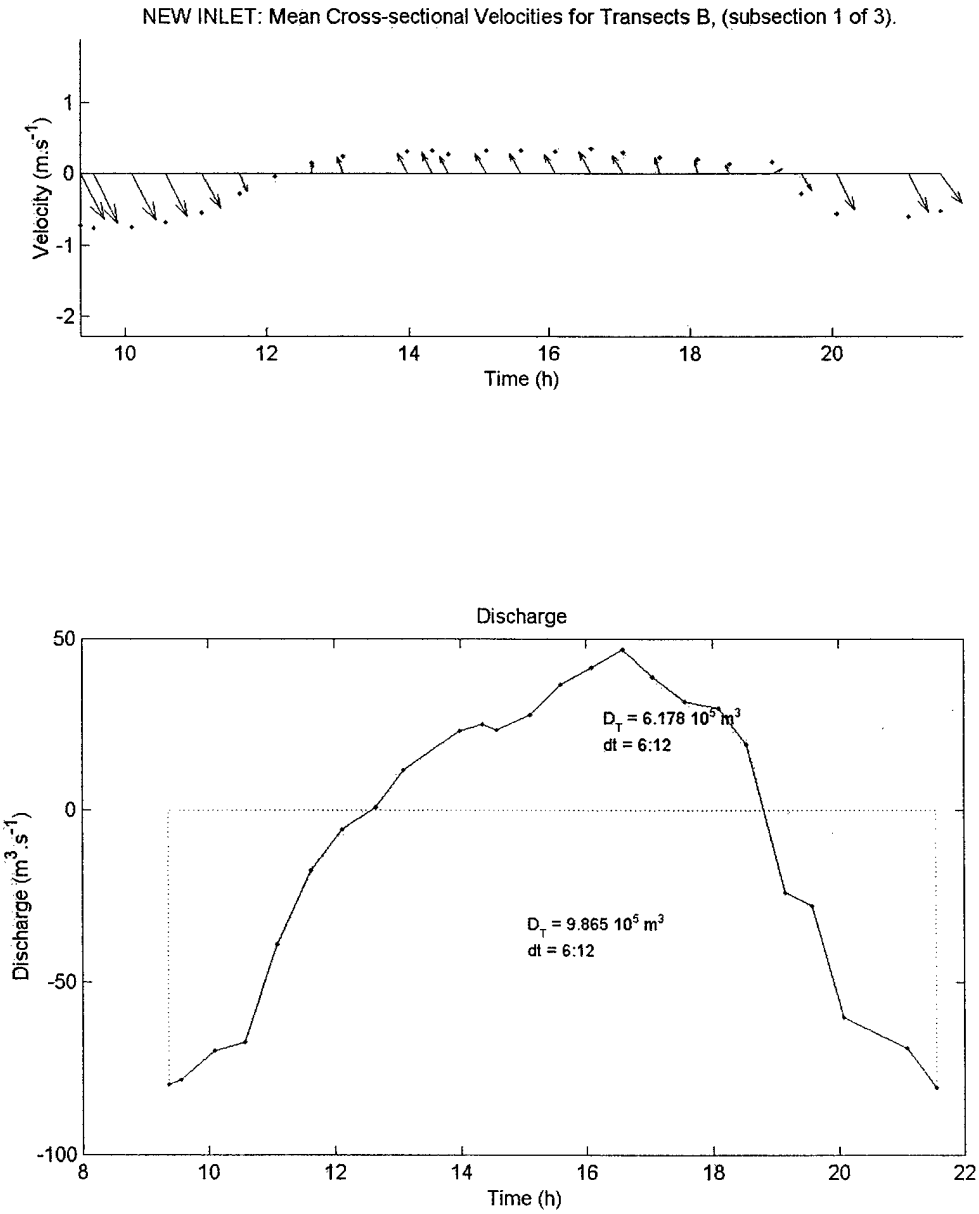
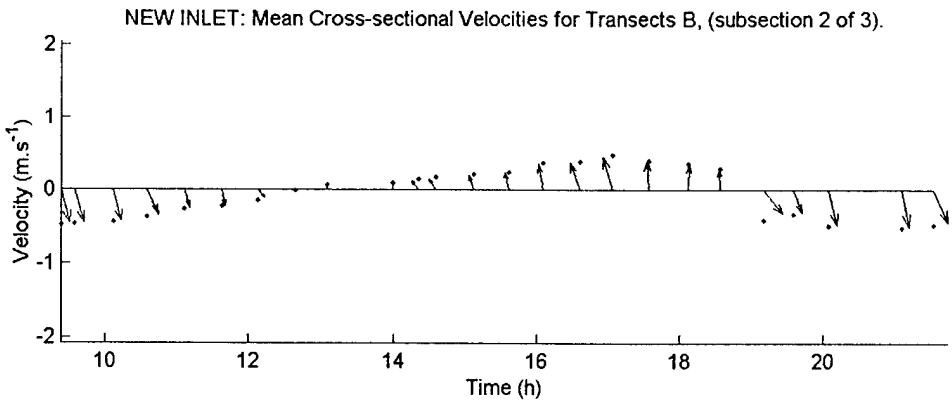


Figure C.3.2 Transect B (1/3) Velocity and Discharge, New Ancão Inlet.



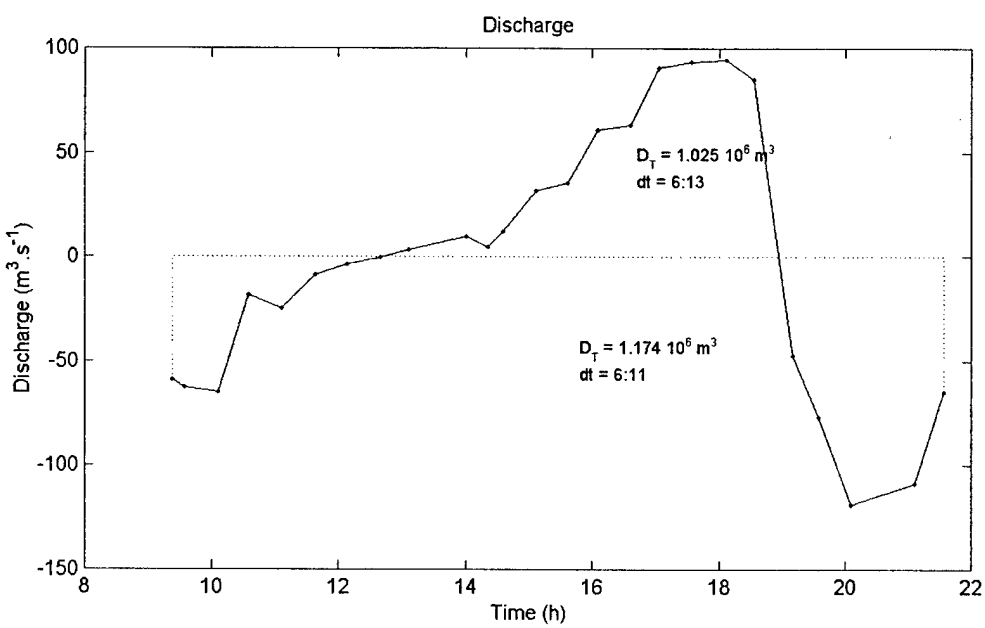
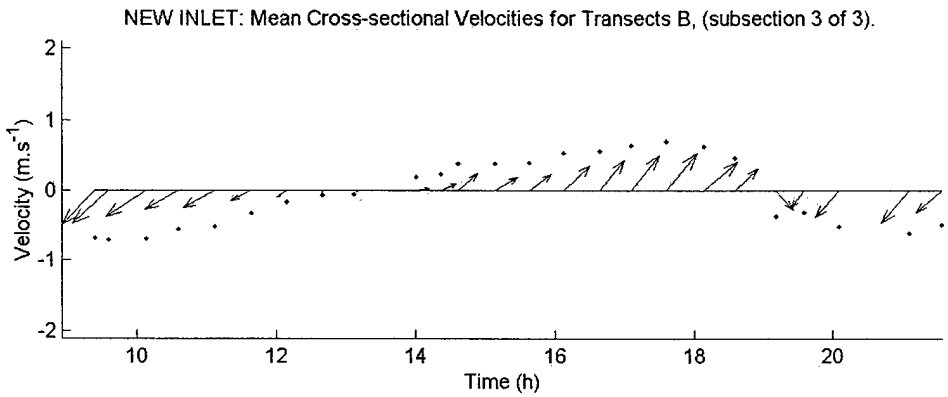


Figure C.3.3 Transect B (2/3) Velocity and Discharge, New Ancão Inlet.



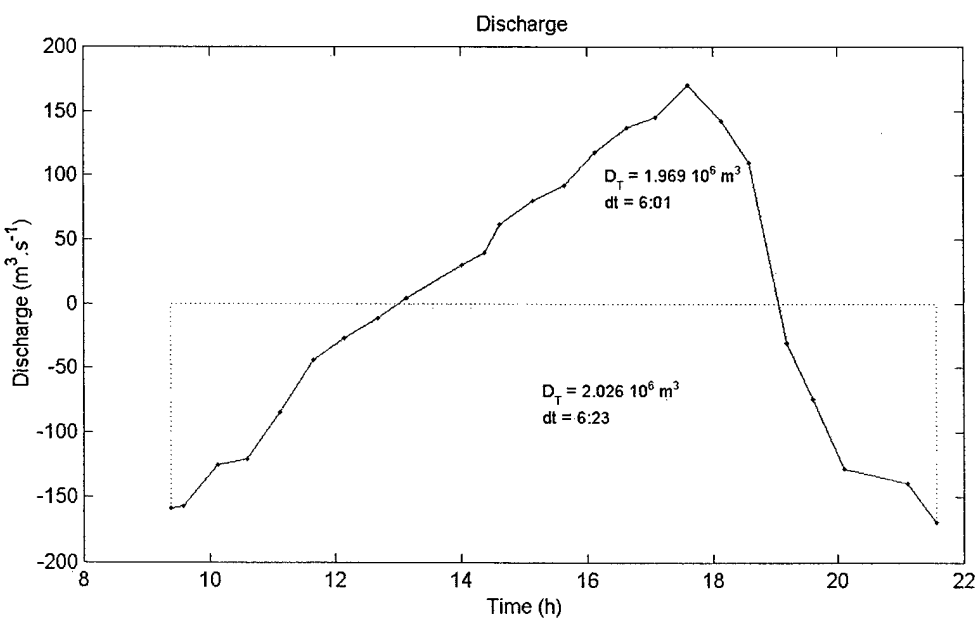
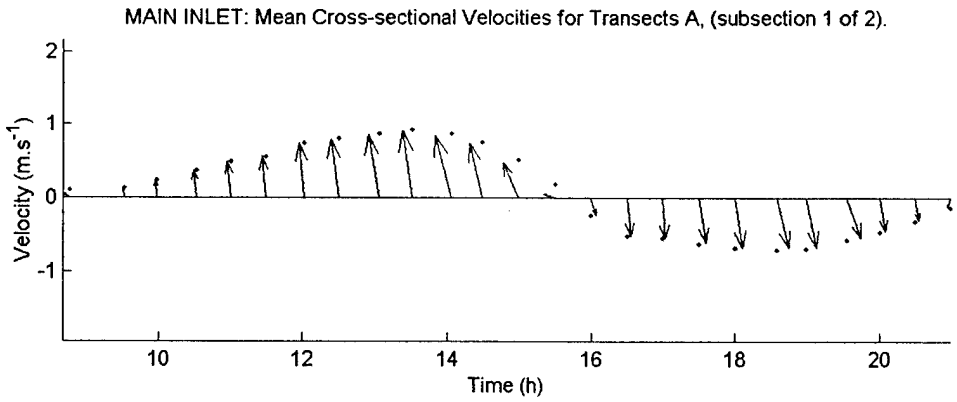


Figure C.3.4 Transect B (3/3) Velocity and Discharge, New Ancão Inlet.



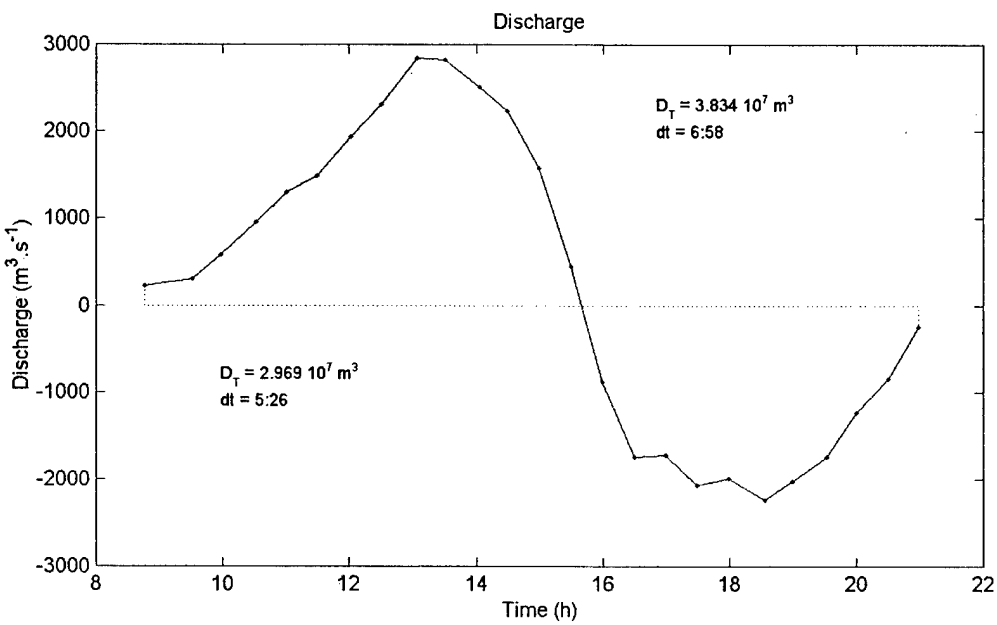
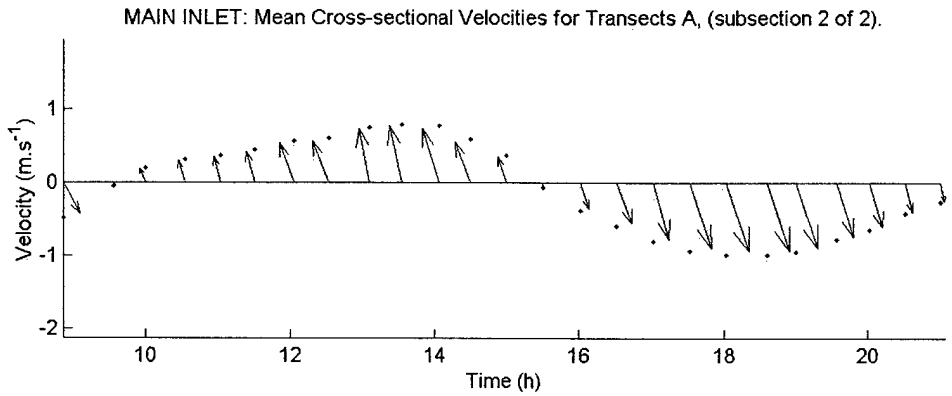


Figure C.3.5 Transect A (1/2) Velocity and Discharge, Main Inlet.



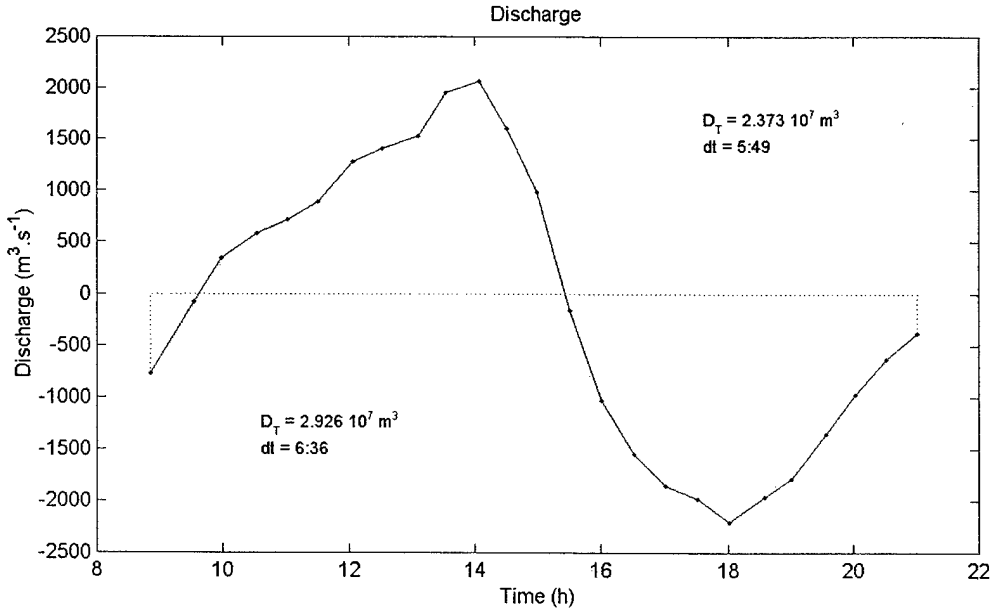
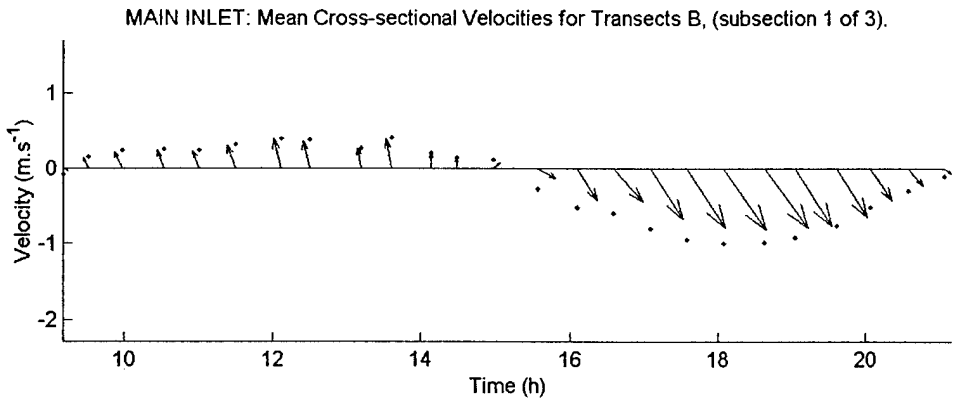


Figure C.3.6 Transect A (2/2) Velocity and Discharge, Main Inlet.



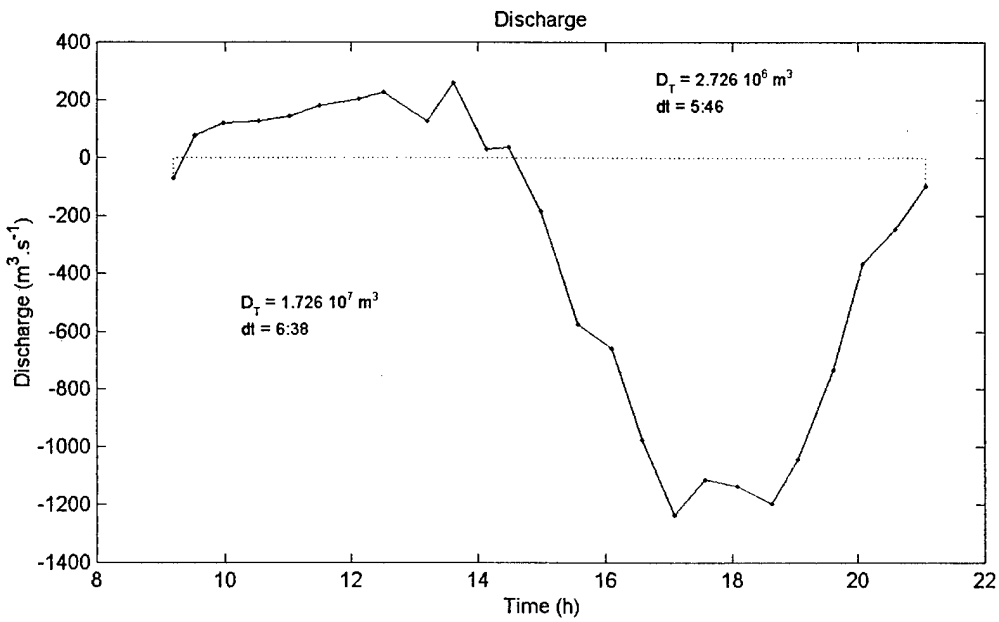
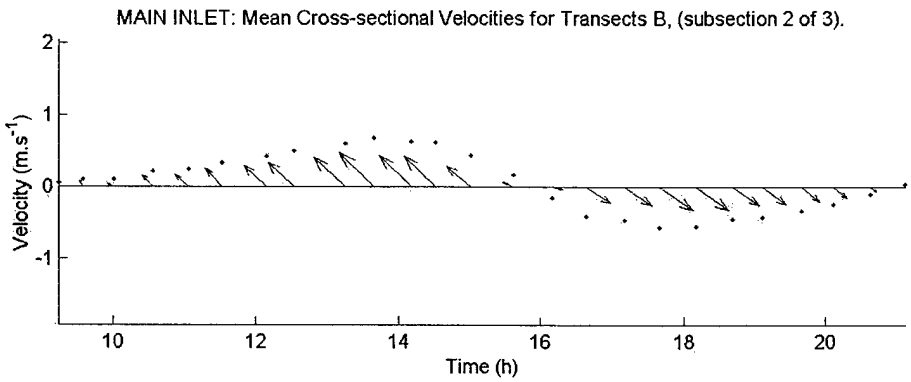


Figure C.3.7 Transect B (1/3) Velocity and Discharge, Main Inlet.



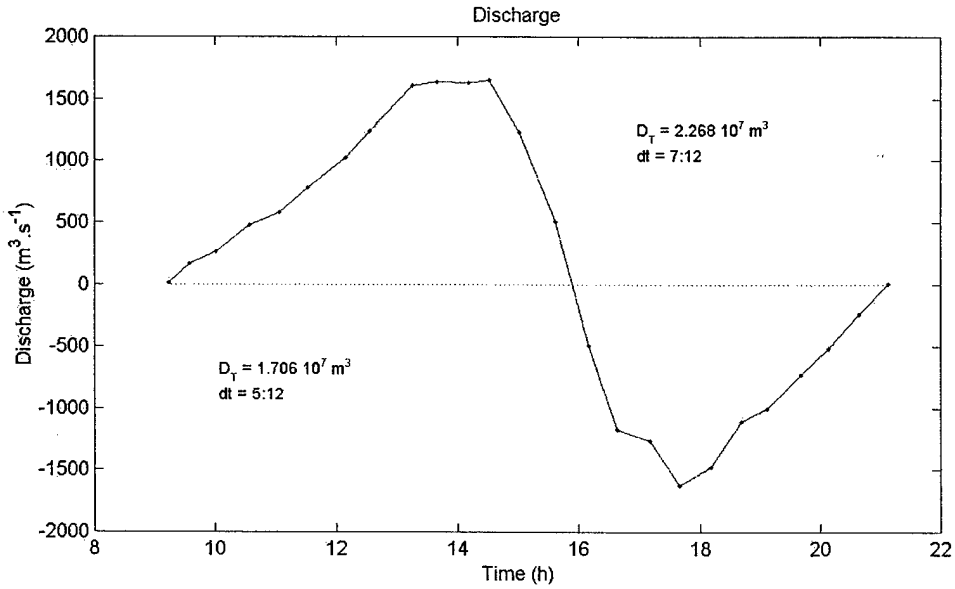
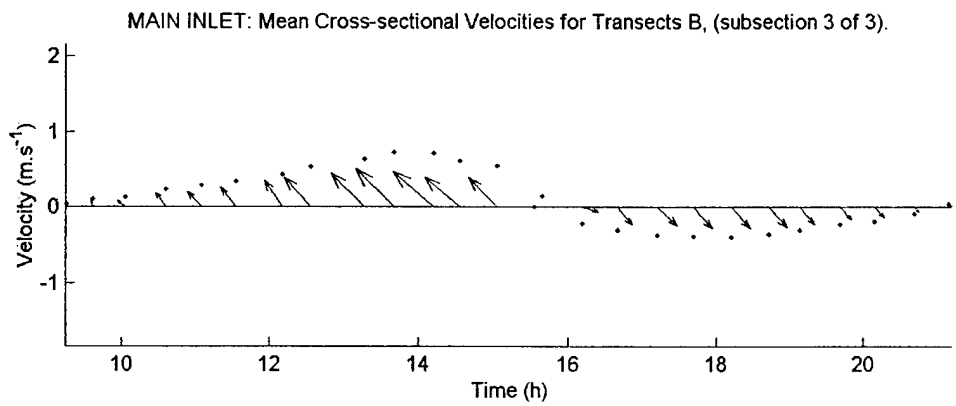


Figure C.3.8 Transect B (2/3) Velocity and Discharge, Main Inlet.



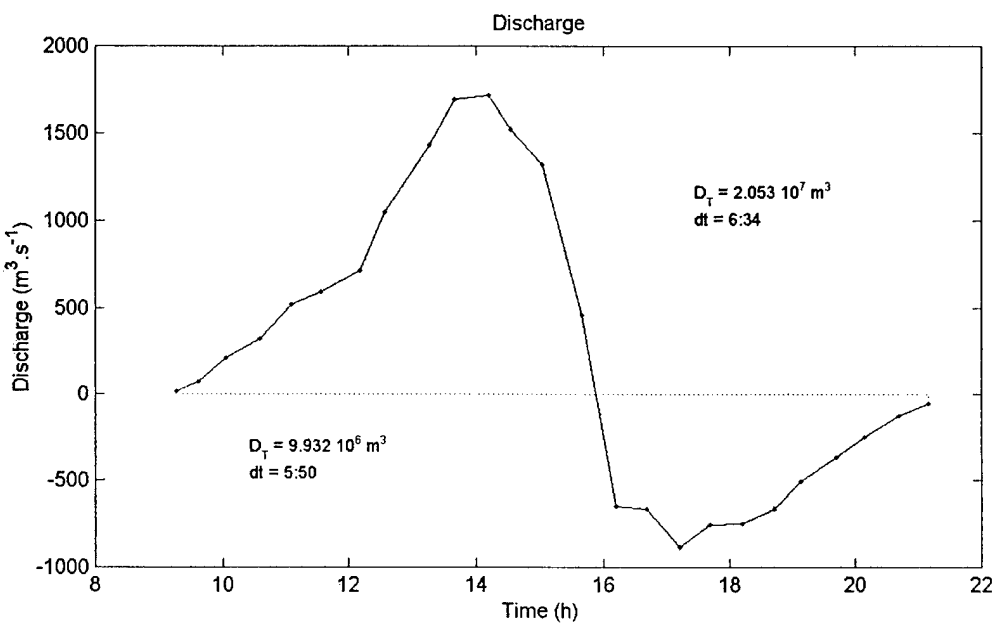
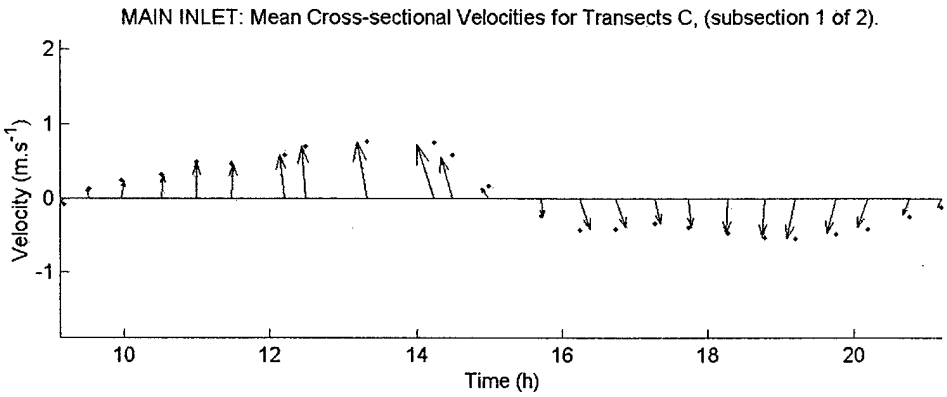


Figure C.3.9 Transect B (3/3) Velocity and Discharge, Main Inlet.



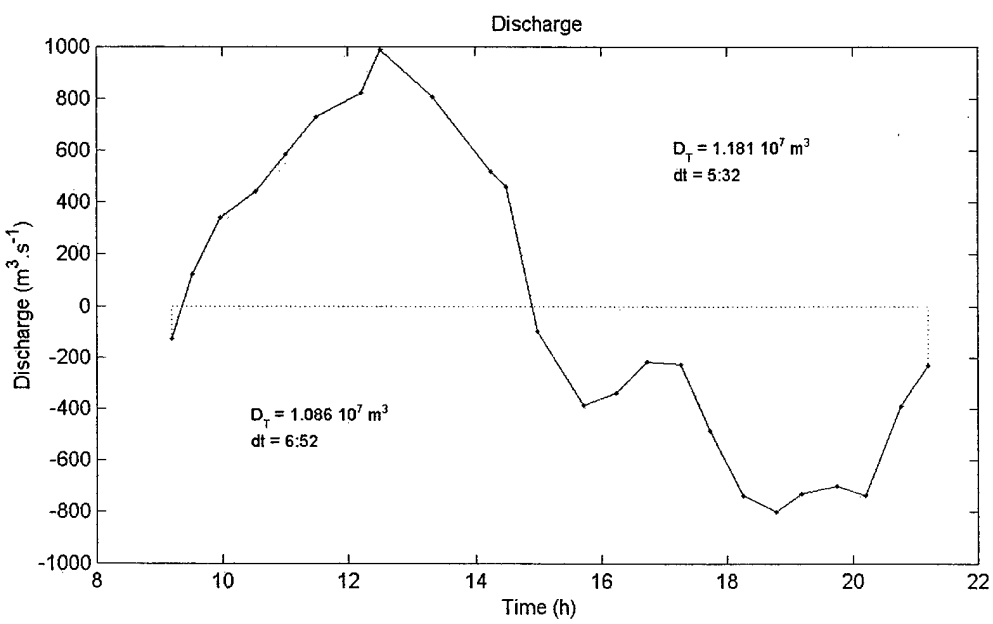
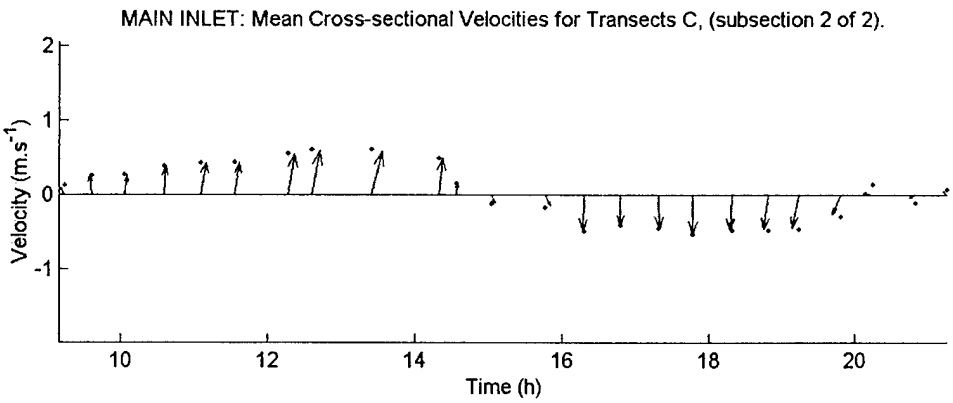


Figure C.3.10 Transect C (1/2) Velocity and Discharge, Main Inlet.



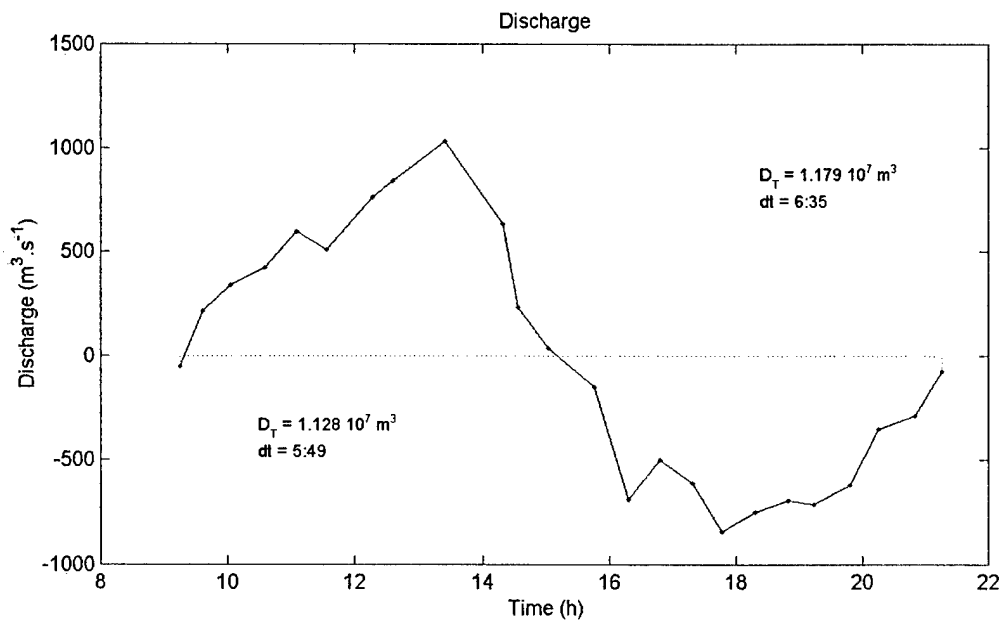


Figure C.3.11 Transect C (2/2) Velocity and Discharge, Main Inlet.

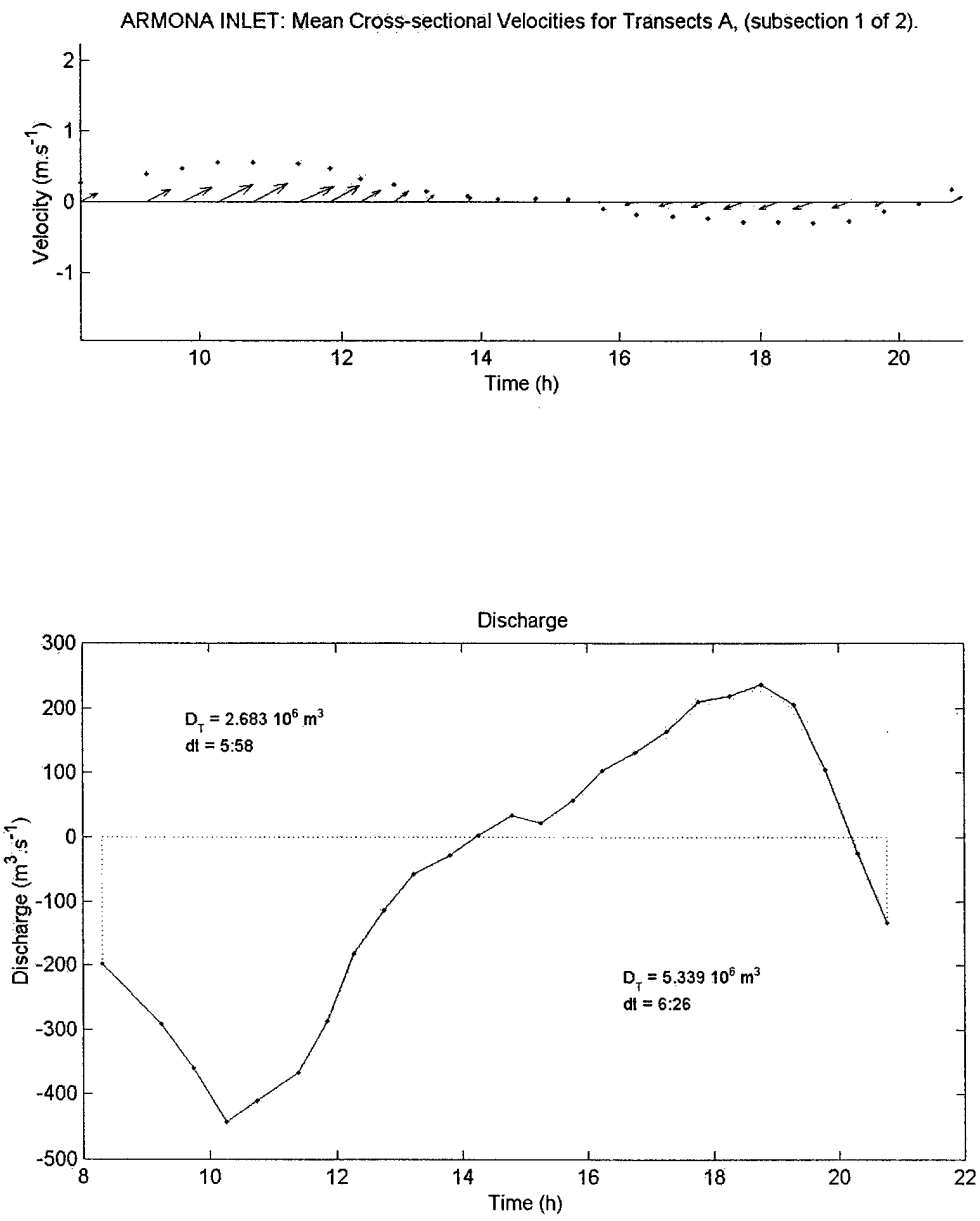
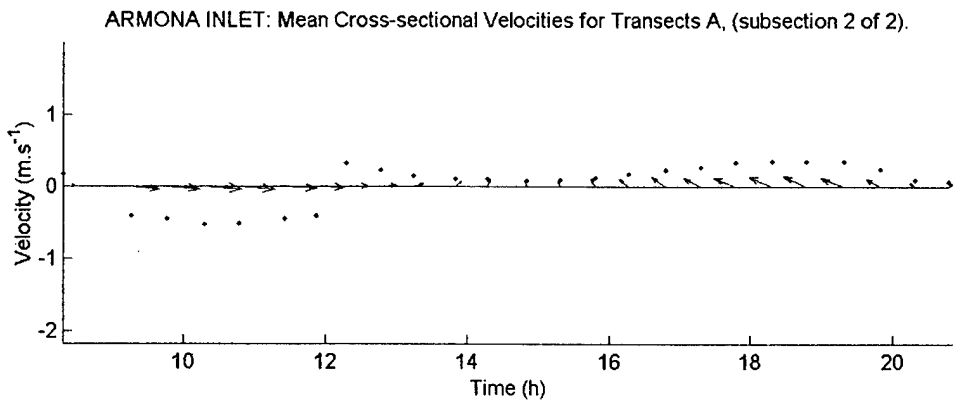


Figure C.3.12 Transect A (1/2) Velocity and Discharge, Armona Inlet.



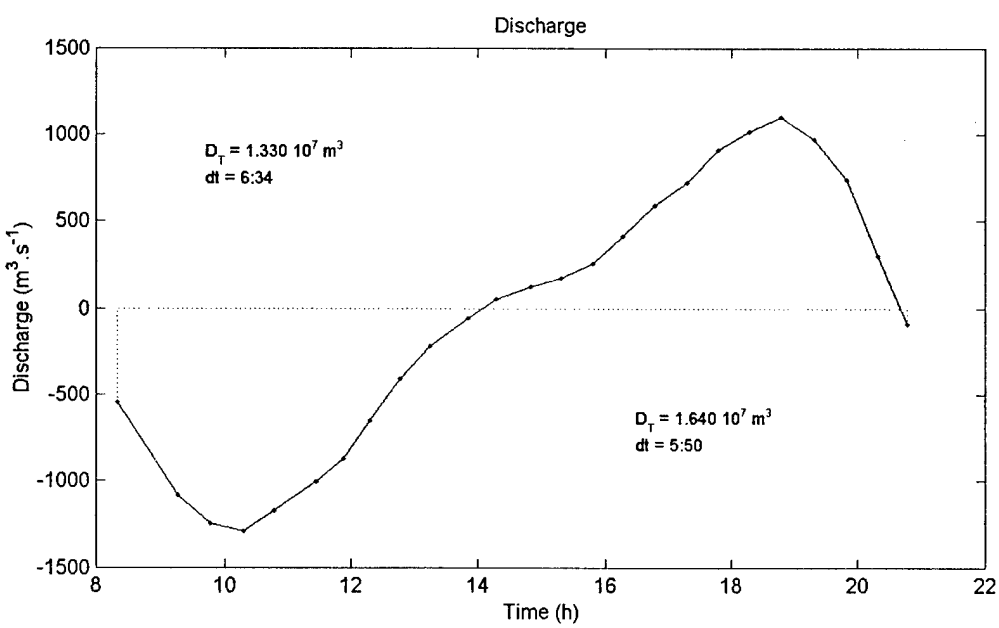
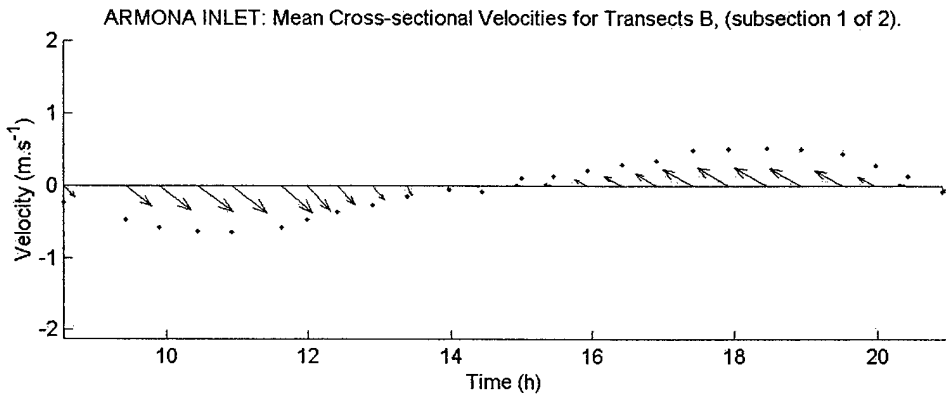


Figure C.3.13 Transect A (2/2) Velocity and Discharge, Armona Inlet.



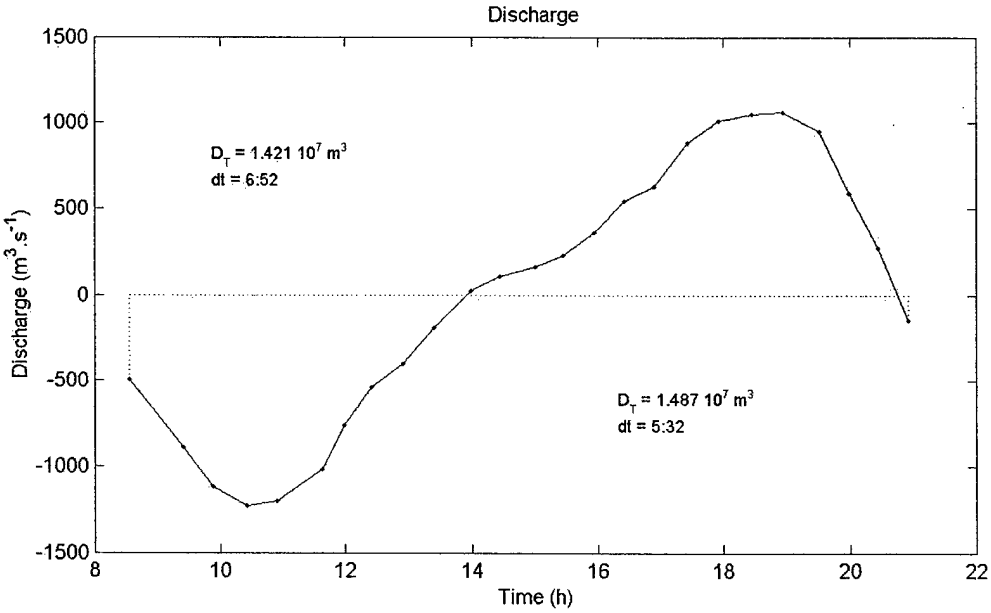
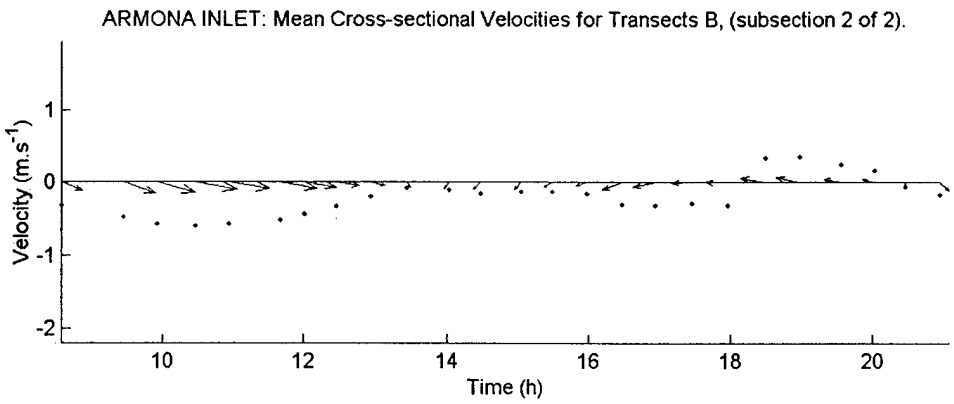


Figure C.3.14 Transect B (1/2) Velocity and Discharge, Armona Inlet.



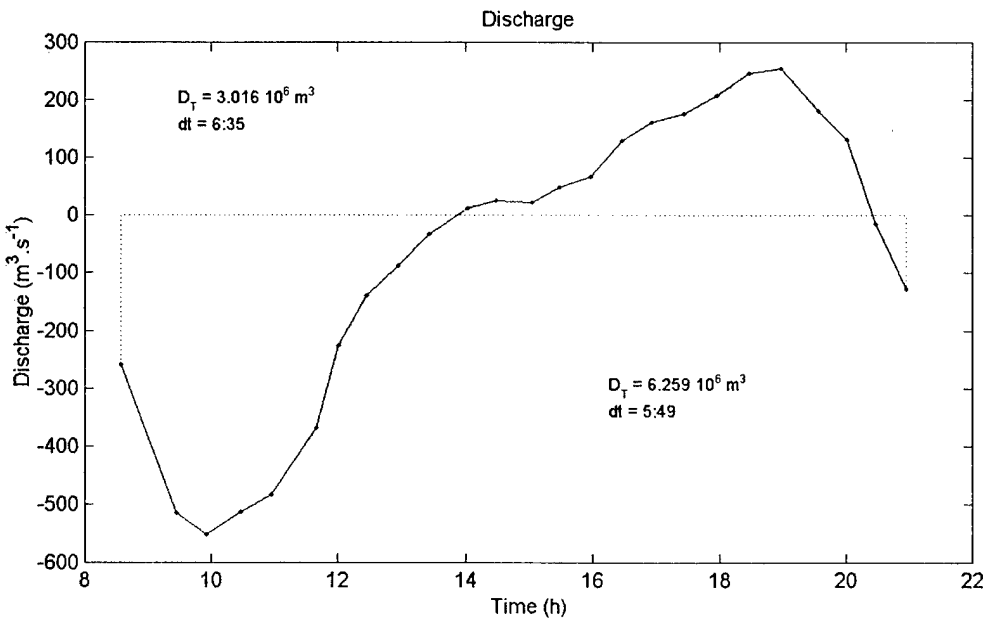


Figure C.3.15 Transect B (2/2) Velocity and Discharge, Armona Inlet.

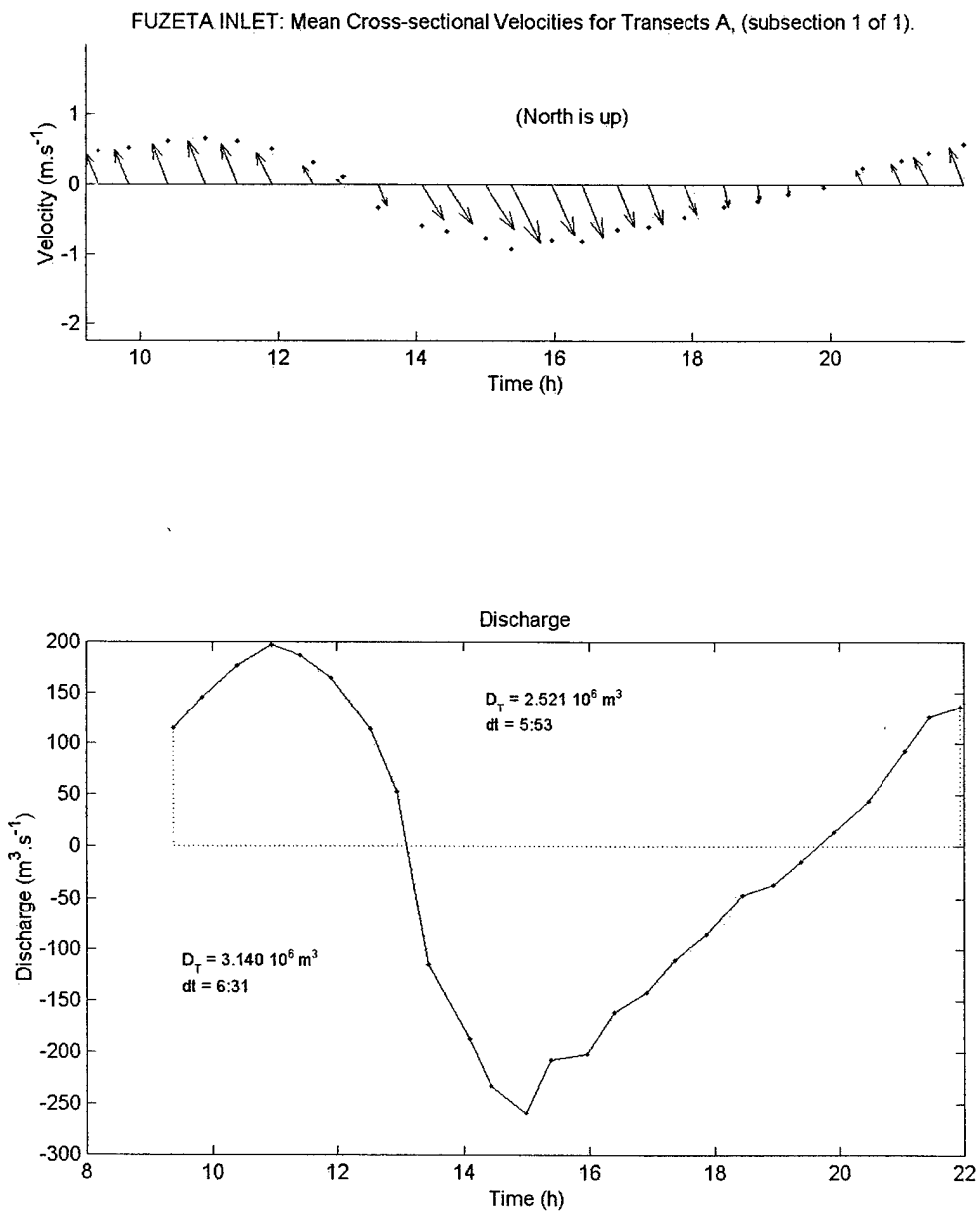
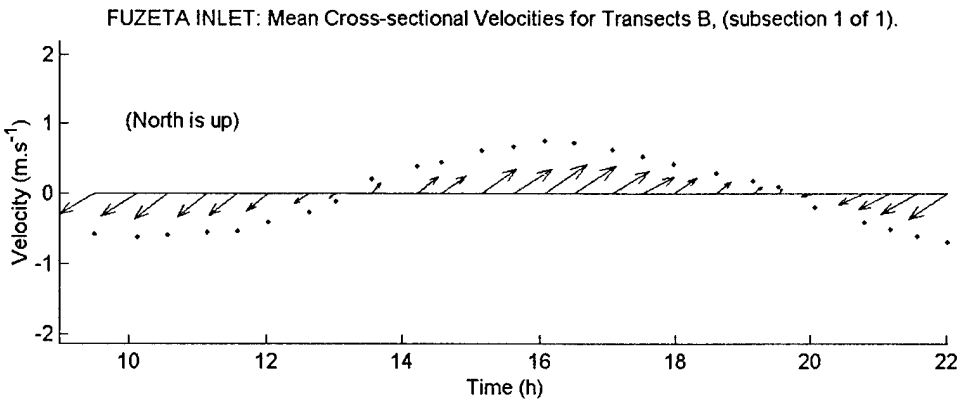


Figure C.3.16 Transect A (1/1) Velocity and Discharge, Fuzeta Inlet.



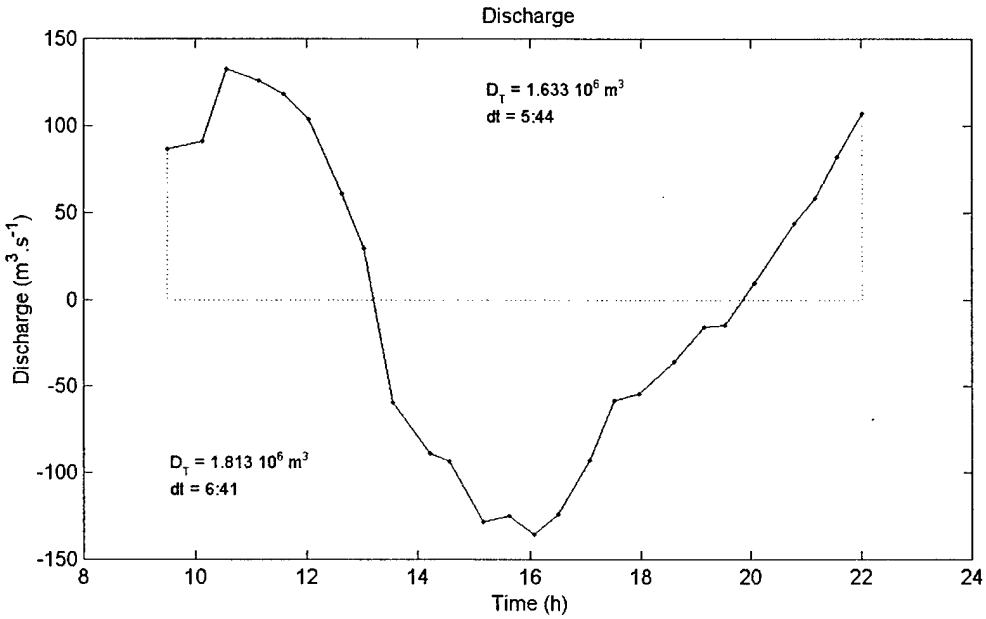


Figure C.3.17 Transect B (1/1) Velocity and Discharge, Fuzeta Inlet.

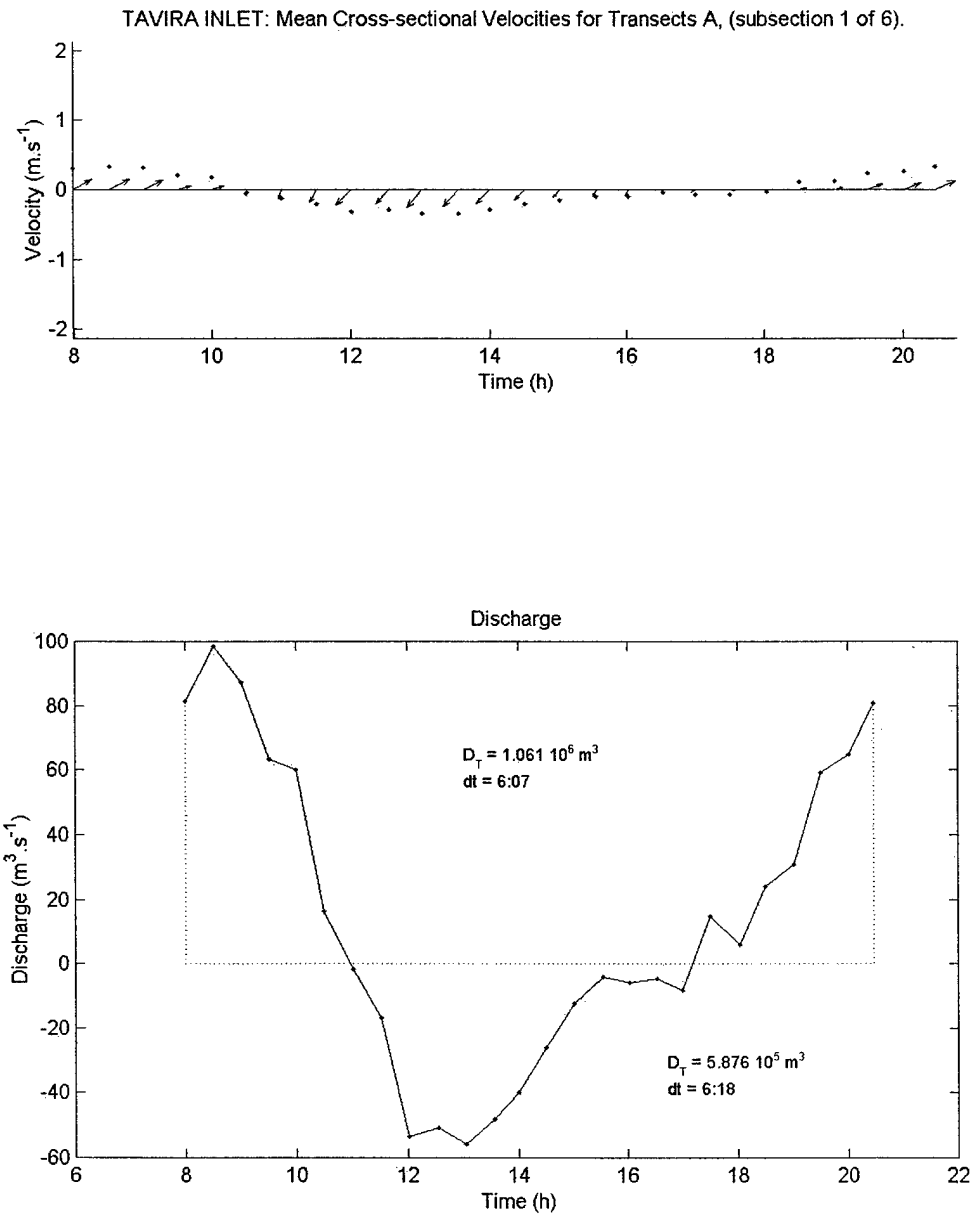


Figure C.3.18 Transect A (1/6) Velocity and Discharge, Tavira Inlet.

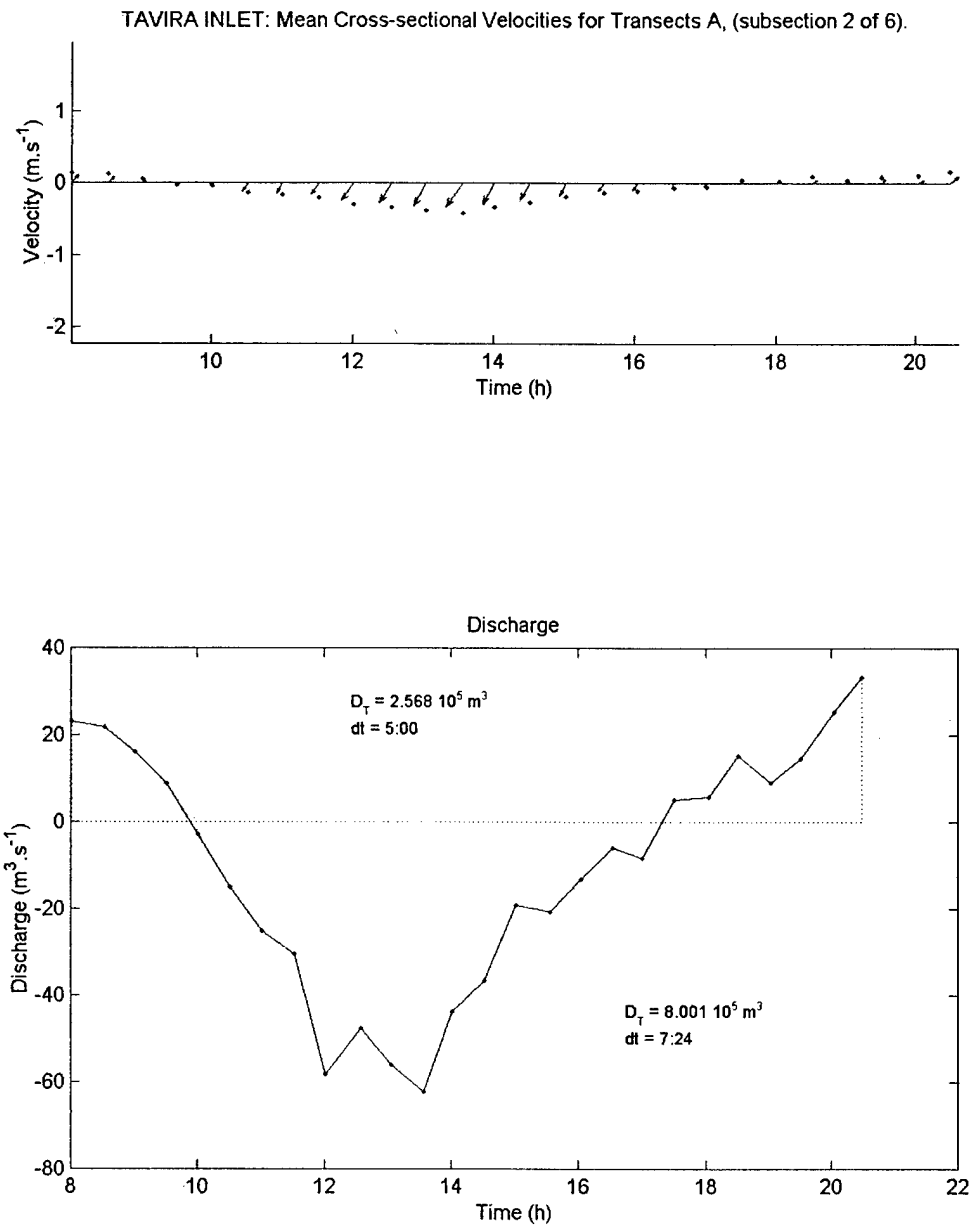


Figure C.3.19 Transect A (2/6) Velocity and Discharge, Tavira Inlet.

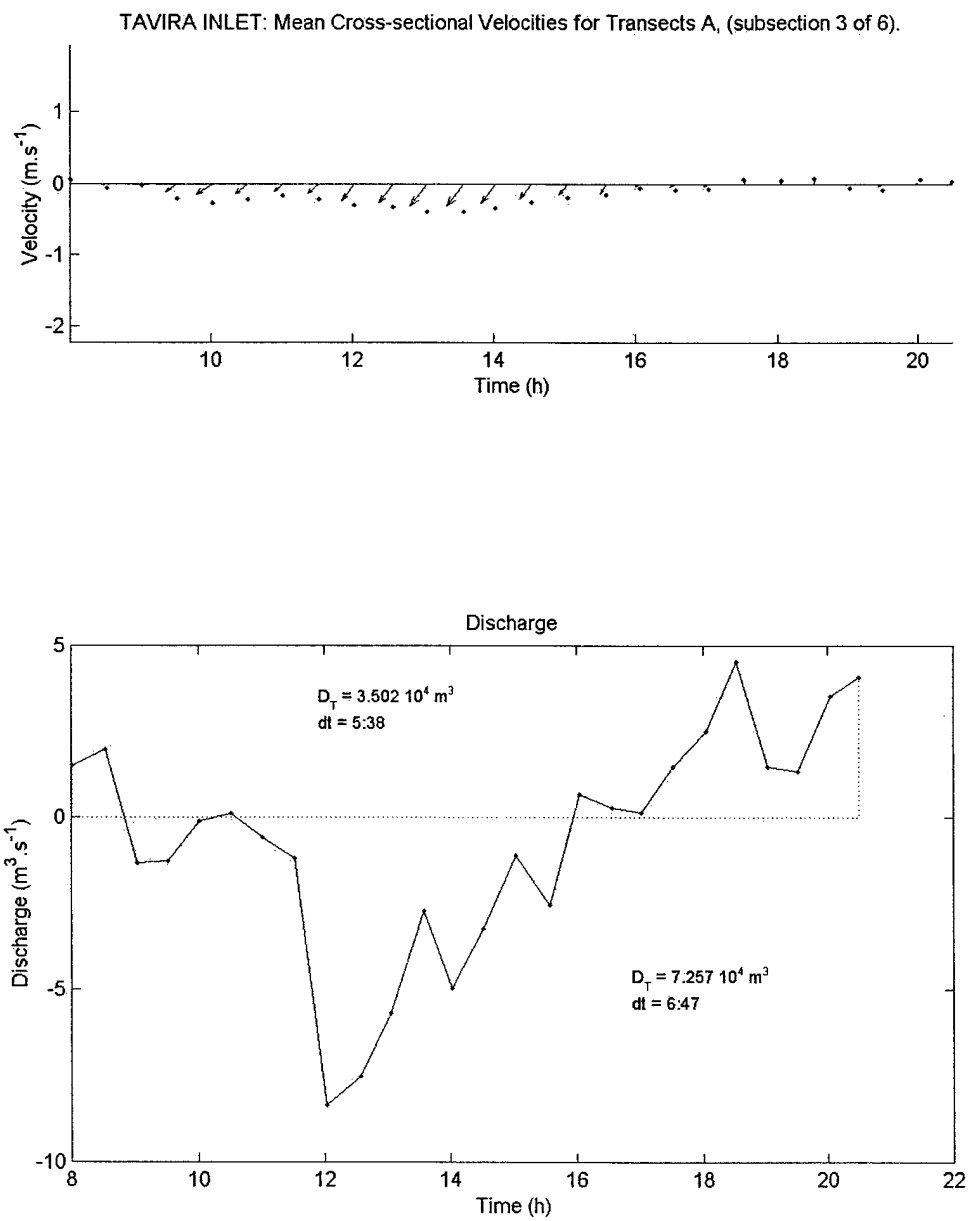
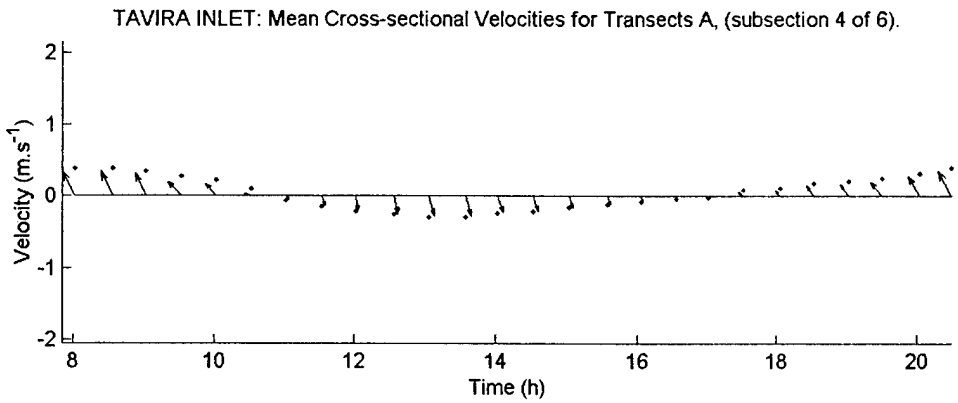


Figure C.3.20 Transect A (3/6) Velocity and Discharge, Tavira Inlet.



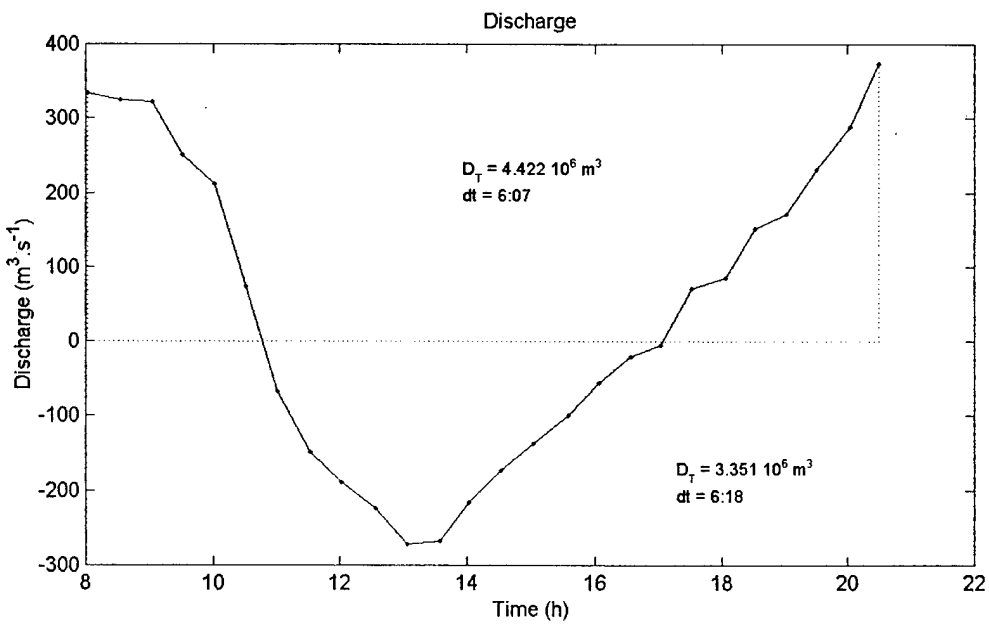
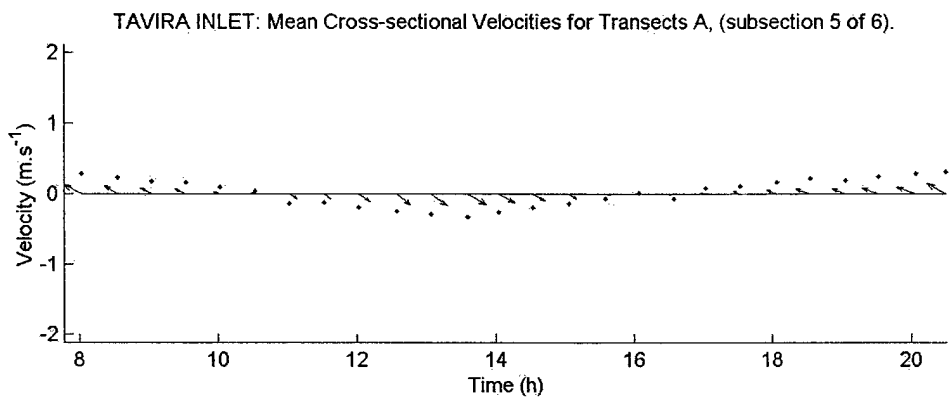


Figure C.3.21 Transect A (4/6) Velocity and Discharge, Tavira Inlet.



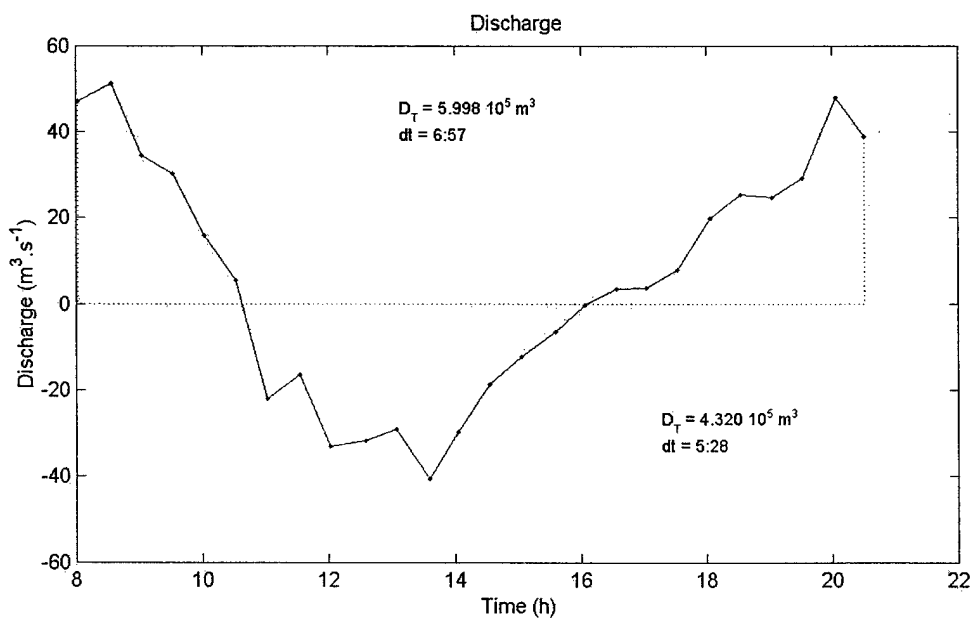
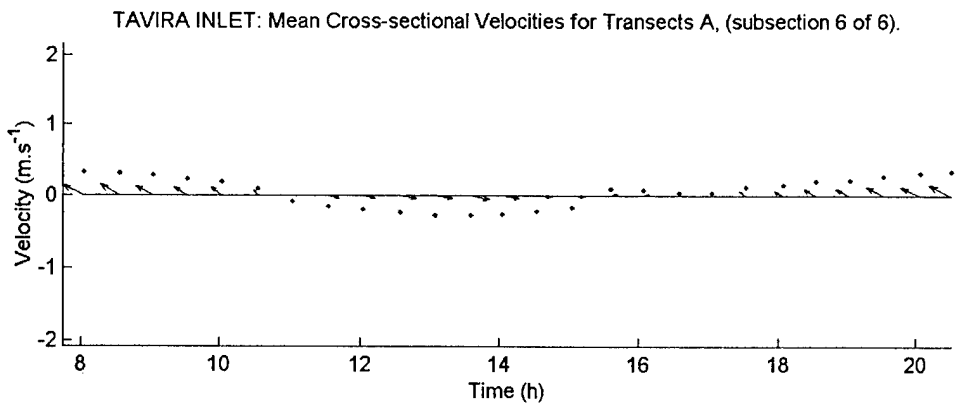


Figure C.3.22 Transect A (5/6) Velocity and Discharge, Tavira Inlet.



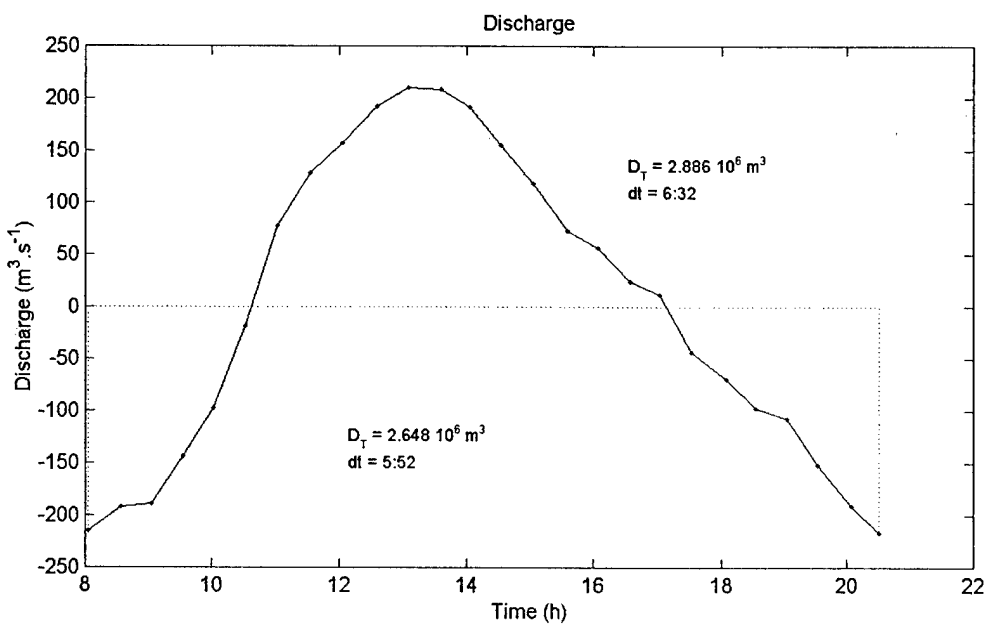
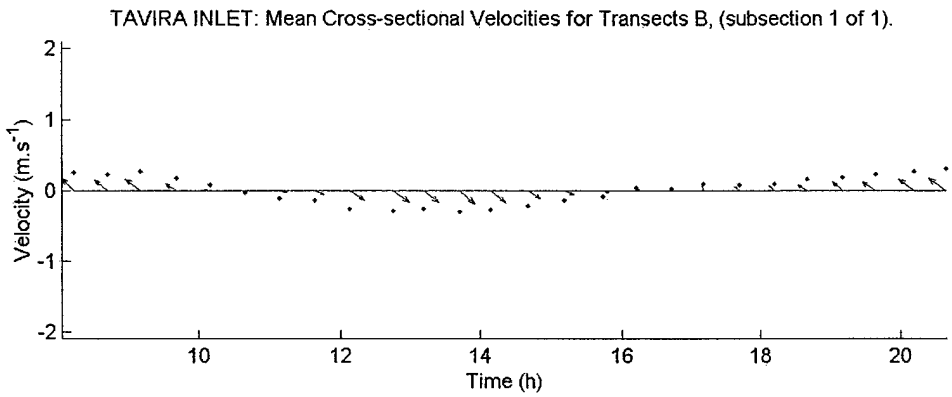


Figure C.3.23 Transect A (6/6) Velocity and Discharge, Tavira Inlet.



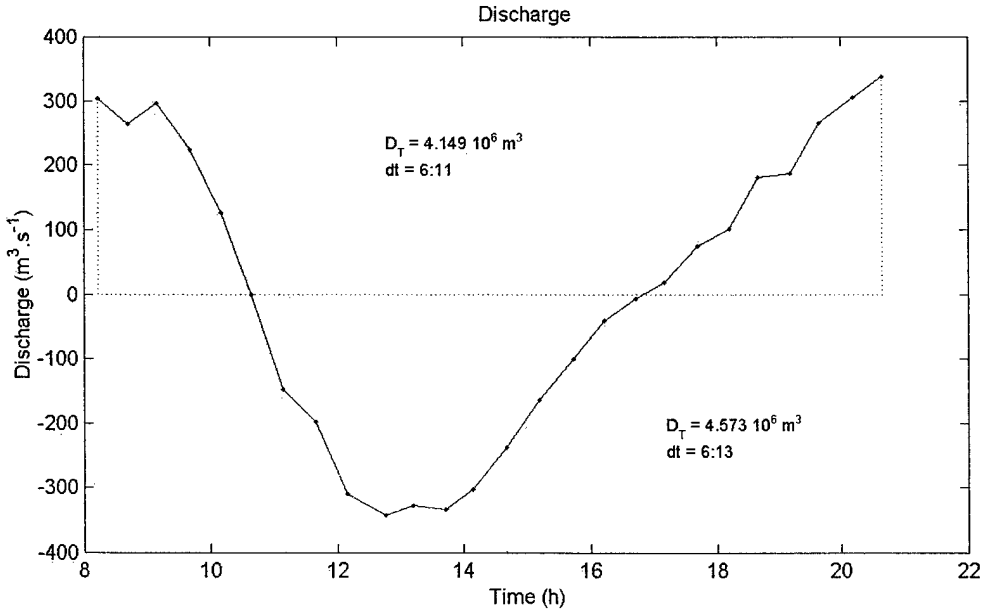


Figure C.3.24 Transect B (1/1) Velocity and Discharge, Tavira Inlet.

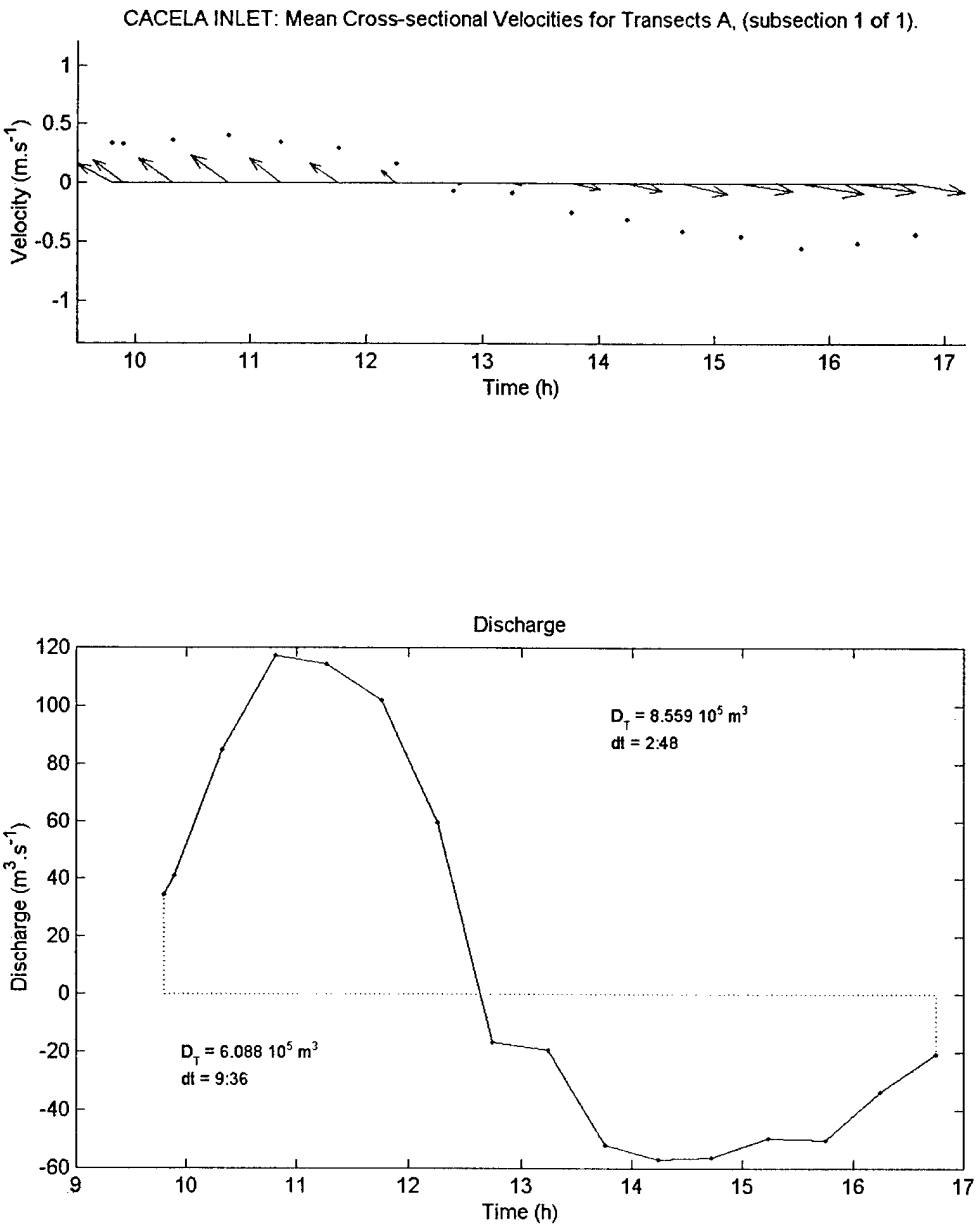


Figure C.3.25 Transect A (1/1) Velocity and Discharge, Cacela Inlet.

ANNEX D: Tidal Harmonic Analysis Results

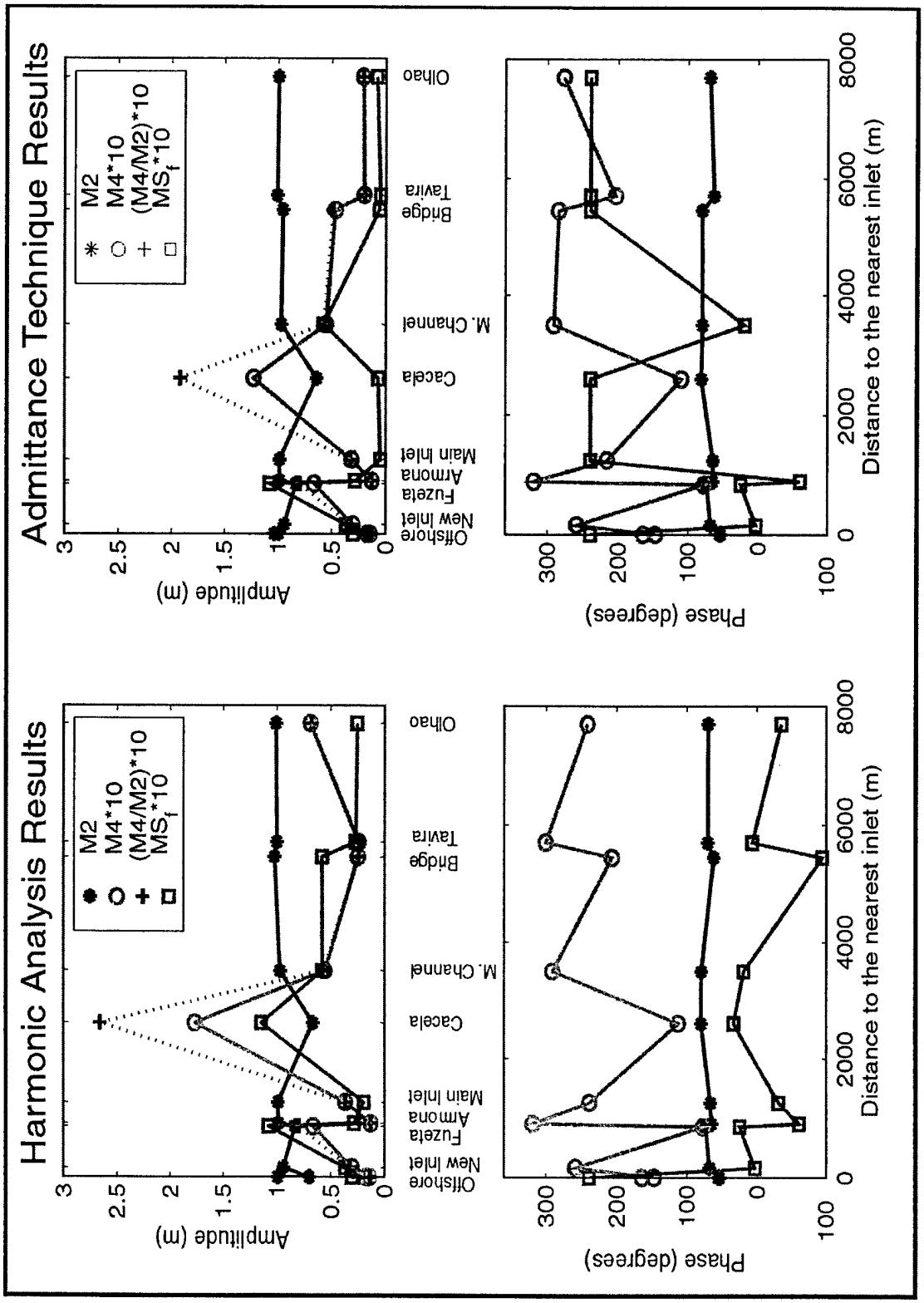


Figure D.1 Harmonic Analysis and Admittance Technique Results.

The program outputs, for each tidal constituent, the amplitude (meters) and phases (degrees), AL and GL respectively and the same amplitudes and phases after nodal modulation and astronomical argument adjustments, A and G.

Table D-1 Results for TG1

NUMBER OF VALID DATA = 913 AVERAGE = 1.68 STANDARD DEVIATION = .77
THEORETICAL RMS = .07 MATRIX CONDITION = .33
Bridge (Portugal) GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN 8096 5H 21/ 1/99 TO 16H 28/ 2/99
NO.OBS.= 914 NO.PTS.ANAL.= 914 MIDPT=15H 9/ 2/99 SEPARATION =1.00

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	8096	199/ 299	1.6812	360.00	1.6812	360.00
2	MM	.00151215	8096	199/ 299	.0093	164.59	.0093	327.18
3	MSF	.00282193	8096	199/ 299	.0575	19.25	.0575	168.87
4	ALP1	.03439657	8096	199/ 299	.0030	157.00	.0026	230.95
5	2Q1	.03570635	8096	199/ 299	.0031	155.08	.0027	215.25
6	Q1	.03721850	8096	199/ 299	.0140	299.17	.0122	162.74
7	O1	.03873065	8096	199/ 299	.0632	330.59	.0541	357.42
8	NO1	.04026859	8096	199/ 299	.0020	207.07	.0019	164.77
9	K1	.04178075	8096	199/ 299	.0678	93.24	.0619	185.14
10	J1	.04329290	8096	199/ 299	.0072	188.98	.0065	88.79
11	OO1	.04483084	8096	199/ 299	.0114	132.02	.0073	127.85
12	UPS1	.04634299	8096	199/ 299	.0030	228.56	.0018	20.60
13	EPS2	.07617731	8096	199/ 299	.0199	129.55	.0212	296.70
14	MU2	.07768947	8096	199/ 299	.0529	145.75	.0550	117.18
15	N2	.07899925	8096	199/ 299	.1669	72.69	.1724	31.76
16	M2	.08051140	8096	199/ 299	.9710	79.73	1.0006	201.46
17	L2	.08202355	8096	199/ 299	.0207	80.66	.0209	194.92
18	S2	.08333334	8096	199/ 299	.3499	127.68	.3494	37.60
19	ETA2	.08507364	8096	199/ 299	.0312	144.70	.0240	322.16
20	MO3	.11924210	8096	199/ 299	.0112	220.61	.0098	9.18
21	M3	.12076710	8096	199/ 299	.0046	329.41	.0048	331.87
22	MK3	.12229210	8096	199/ 299	.0159	340.75	.0149	194.39
23	SK3	.12511410	8096	199/ 299	.0077	52.65	.0070	54.48
24	MN4	.15951060	8096	199/ 299	.0170	296.66	.0181	17.47
25	M4	.16102280	8096	199/ 299	.0554	291.30	.0588	174.77
26	SN4	.16233260	8096	199/ 299	.0058	346.30	.0060	215.30
27	MS4	.16384470	8096	199/ 299	.0488	359.78	.0502	31.44
28	S4	.16666670	8096	199/ 299	.0148	112.65	.0147	292.50
29	2MK5	.20280360	8096	199/ 299	.0108	225.29	.0104	200.66
30	2SK5	.20844740	8096	199/ 299	.0033	51.08	.0030	322.83
31	2MN6	.24002200	8096	199/ 299	.0158	213.99	.0173	56.54
32	M6	.24153420	8096	199/ 299	.0334	212.90	.0366	218.10
33	2MS6	.24435610	8096	199/ 299	.0453	264.67	.0480	58.06
34	2SM6	.24717810	8096	199/ 299	.0157	346.61	.0161	288.19
35	3MK7	.28331490	8096	199/ 299	.0022	95.76	.0022	192.86
36	M8	.32204560	8096	199/ 299	.0054	29.69	.0061	156.62

Table D-2 Results for TG2

```
NUMBER OF VALID DATA =    927  AVERAGE =  2.07  STANDARD DEVIATION =    .74
THEORETICAL RMS =    .07  MATRIX CONDITION =    .33
New Inlet (Portugal)      GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS  STN  5078 17H 21/ 1/99 TO 8H  1/ 3/99
NO.OBS.=   928  NO.PTS.ANAL.=   928 MIDPT= 0H 10/ 2/99 SEPARATION =1.00
```

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	5078	199/ 399	2.0774	.00	2.0774	.00
2	MM	.00151215	5078	199/ 399	.0193	186.15	.0193	343.84
3	MSF	.00282193	5078	199/ 399	.0367	2.72	.0367	143.20
4	ALP1	.03439657	5078	199/ 399	.0018	157.97	.0016	120.48
5	2Q1	.03570635	5078	199/ 399	.0028	123.93	.0025	68.41
6	Q1	.03721850	5078	199/ 399	.0141	281.27	.0122	24.25
7	O1	.03873065	5078	199/ 399	.0640	321.77	.0548	223.12
8	NO1	.04026859	5078	199/ 399	.0030	148.30	.0029	335.52
9	K1	.04178075	5078	199/ 399	.0669	83.14	.0611	39.67
10	J1	.04329290	5078	199/ 399	.0055	147.34	.0050	266.88
11	OO1	.04483084	5078	199/ 399	.0072	100.82	.0046	311.41
12	UPS1	.04634299	5078	199/ 399	.0027	227.92	.0017	229.83
13	EPS2	.07617731	5078	199/ 399	.0165	126.84	.0176	47.18
14	MU2	.07768947	5078	199/ 399	.0258	135.52	.0268	215.24
15	N2	.07899925	5078	199/ 399	.1616	57.37	.1670	120.49
16	M2	.08051140	5078	199/ 399	.9389	67.99	.9675	288.86
17	L2	.08202355	5078	199/ 399	.0156	89.66	.0157	298.16
18	S2	.08333334	5078	199/ 399	.3456	111.77	.3450	111.70
19	ETA2	.08507364	5078	199/ 399	.0251	130.18	.0193	32.00
20	MO3	.11924210	5078	199/ 399	.0078	205.09	.0069	327.32
21	M3	.12076710	5078	199/ 399	.0033	297.91	.0035	269.08
22	MK3	.12229210	5078	199/ 399	.0118	323.57	.0111	140.98
23	SK3	.12511410	5078	199/ 399	.0088	28.86	.0080	345.32
24	MN4	.15951060	5078	199/ 399	.0072	255.90	.0076	179.90
25	M4	.16102280	5078	199/ 399	.0310	258.41	.0329	340.16
26	SN4	.16233260	5078	199/ 399	.0024	323.31	.0024	26.35
27	MS4	.16384470	5078	199/ 399	.0311	325.00	.0320	185.80
28	S4	.16666670	5078	199/ 399	.0094	72.22	.0093	72.06
29	2MK5	.20280360	5078	199/ 399	.0039	234.52	.0037	272.81
30	2SK5	.20844740	5078	199/ 399	.0013	324.46	.0012	280.85
31	2MN6	.24002200	5078	199/ 399	.0069	229.80	.0076	14.68
32	M6	.24153420	5078	199/ 399	.0096	239.08	.0105	181.71
33	2MS6	.24435610	5078	199/ 399	.0167	270.37	.0177	352.05
34	2SM6	.24717810	5078	199/ 399	.0086	318.94	.0088	179.66
35	3MK7	.28331490	5078	199/ 399	.0023	352.58	.0023	251.74
36	M8	.32204560	5078	199/ 399	.0028	342.34	.0032	145.85

Table D-3 Results for TG3

NUMBER OF VALID DATA = 911 AVERAGE = 1.97 STANDARD DEVIATION = .79
THEORETICAL RMS = .06 MATRIX CONDITION = .33
M. Channel. (Portuga GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN 3853 18H 21/ 1/99 TO 17H 28/ 2/99
NO.OBS.= 912 NO.PTS.ANAL.= 912 MIDPT=17H 9/ 2/99 SEPARATION =1.00

NO	NAME	FREQUENCY	STN	M-Y/	M-Y	A	G	AL	GL
1	Z0	.00000000	3853	199/	299	1.9739	360.00	1.9739	360.00
2	MM	.00151215	3853	199/	299	.0298	183.76	.0298	345.27
3	MSF	.00282193	3853	199/	299	.0256	325.04	.0256	112.62
4	ALP1	.03439657	3853	199/	299	.0037	178.18	.0032	227.37
5	2Q1	.03570635	3853	199/	299	.0033	93.49	.0029	127.95
6	Q1	.03721850	3853	199/	299	.0154	281.07	.0133	117.85
7	O1	.03873065	3853	199/	299	.0644	318.39	.0551	317.34
8	NO1	.04026859	3853	199/	299	.0013	197.68	.0013	126.37
9	K1	.04178075	3853	199/	299	.0694	80.18	.0633	142.00
10	J1	.04329290	3853	199/	299	.0053	158.95	.0048	27.59
11	OO1	.04483084	3853	199/	299	.0048	112.96	.0031	76.51
12	UPS1	.04634299	3853	199/	299	.0033	248.20	.0020	6.88
13	EPS2	.07617731	3853	199/	299	.0114	104.83	.0122	217.13
14	MU2	.07768947	3853	199/	299	.0227	119.44	.0236	34.94
15	N2	.07899925	3853	199/	299	.1764	58.66	.1823	320.86
16	M2	.08051140	3853	199/	299	1.0090	70.02	1.0397	133.79
17	L2	.08202355	3853	199/	299	.0221	92.80	.0222	148.00
18	S2	.08333334	3853	199/	299	.3805	113.34	.3799	323.27
19	ETA2	.08507364	3853	199/	299	.0213	126.74	.0163	242.95
20	MO3	.11924210	3853	199/	299	.0078	169.57	.0069	232.29
21	M3	.12076710	3853	199/	299	.0053	290.91	.0055	206.42
22	MK3	.12229210	3853	199/	299	.0122	292.50	.0115	58.09
23	SK3	.12511410	3853	199/	299	.0059	356.73	.0054	268.47
24	MN4	.15951060	3853	199/	299	.0205	233.24	.0219	199.20
25	M4	.16102280	3853	199/	299	.0687	241.49	.0729	9.02
26	SN4	.16233260	3853	199/	299	.0102	278.07	.0106	30.19
27	MS4	.16384470	3853	199/	299	.0548	302.31	.0563	216.00
28	S4	.16666670	3853	199/	299	.0100	27.34	.0100	87.19
29	2MK5	.20280360	3853	199/	299	.0059	171.51	.0057	.86
30	2SK5	.20844740	3853	199/	299	.0014	28.00	.0013	149.67
31	2MN6	.24002200	3853	199/	299	.0078	159.61	.0085	189.34
32	M6	.24153420	3853	199/	299	.0189	167.02	.0207	358.32
33	2MS6	.24435610	3853	199/	299	.0261	214.00	.0277	191.45
34	2SM6	.24717810	3853	199/	299	.0071	267.98	.0072	31.59
35	3MK7	.28331490	3853	199/	299	.0028	292.40	.0028	185.52
36	M8	.32204560	3853	199/	299	.0077	290.39	.0086	185.45

Table D-4 Results for TG4

NUMBER OF VALID DATA = 543 AVERAGE = 1.36 STANDARD DEVIATION = .73
THEORETICAL RMS = .15 MATRIX CONDITION = .72
M. Inlet (Portugal) GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN 8711 12H 22/ 1/99 TO 3H 14/ 2/99
NO.OBS.= 544 NO.PTS.ANAL.= 544 MIDPT=19H 2/ 2/99 SEPARATION =1.00

NO	NAME	FREQUENCY	STN	M-Y/	M-Y	A	G	AL	GL
1	Z0	.00000000	8711	199/	299	1.3599	360.00	1.3599	360.00
2	MSF	.00282193	8711	199/	299	.0196	329.13	.0196	285.35
3	O1	.03873065	8711	199/	299	.0679	319.11	.0580	112.66
4	K1	.04178075	8711	199/	299	.0738	74.87	.0673	113.46
5	M2	.08051140	8711	199/	299	.9902	67.14	1.0205	262.25
6	S2	.08333334	8711	199/	299	.3614	113.14	.3608	263.07
7	M3	.12076710	8711	199/	299	.0057	268.59	.0059	201.12
8	SK3	.12511410	8711	199/	299	.0028	351.76	.0026	180.27
9	M4	.16102280	8711	199/	299	.0365	238.75	.0387	268.98
10	MS4	.16384470	8711	199/	299	.0333	309.82	.0342	294.86
11	S4	.16666670	8711	199/	299	.0085	17.71	.0085	317.56
12	2MK5	.20280360	8711	199/	299	.0036	176.56	.0034	245.39
13	2SK5	.20844740	8711	199/	299	.0019	73.31	.0017	51.75
14	M6	.24153420	8711	199/	299	.0177	157.12	.0193	22.47
15	2MS6	.24435610	8711	199/	299	.0195	206.78	.0207	26.93
16	2SM6	.24717810	8711	199/	299	.0059	288.57	.0060	63.53
17	3MK7	.28331490	8711	199/	299	.0015	313.75	.0015	217.69
18	M8	.32204560	8711	199/	299	.0037	283.46	.0042	343.92

Table D-5 Results for TG5

NUMBER OF VALID DATA = 887 AVERAGE = 2.58 STANDARD DEVIATION = .77
THEORETICAL RMS = .06 MATRIX CONDITION = .34
Armona (Portugal) GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN 8712 14H 22/ 1/99 TO 13H 28/ 2/99
NO.OBS.= 888 NO.PTS.ANAL.= 888 MIDPT= 1H 10/ 2/99 SEPARATION =1.00

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	8712	199/ 299	2.5845	.00	2.5845	.00
2	MM	.00151215	8712	199/ 299	.0362	177.21	.0362	334.36
3	MSF	.00282193	8712	199/ 299	.0285	299.61	.0285	79.07
4	ALP1	.03439657	8712	199/ 299	.0021	111.17	.0018	61.29
5	2Q1	.03570635	8712	199/ 299	.0038	131.29	.0033	62.91
6	Q1	.03721850	8712	199/ 299	.0146	271.48	.0127	1.06
7	O1	.03873065	8712	199/ 299	.0650	316.50	.0556	203.90
8	NO1	.04026859	8712	199/ 299	.0019	190.11	.0018	2.86
9	K1	.04178075	8712	199/ 299	.0684	74.96	.0625	16.45
10	J1	.04329290	8712	199/ 299	.0061	139.19	.0055	243.15
11	OO1	.04483084	8712	199/ 299	.0027	112.41	.0017	306.87
12	UPS1	.04634299	8712	199/ 299	.0007	345.99	.0005	331.21
13	EPS2	.07617731	8712	199/ 299	.0077	98.12	.0081	351.03
14	MU2	.07768947	8712	199/ 299	.0149	115.14	.0155	166.89
15	N2	.07899925	8712	199/ 299	.1718	53.19	.1775	87.87
16	M2	.08051140	8712	199/ 299	.9844	65.34	1.0144	257.23
17	L2	.08202355	8712	199/ 299	.0207	96.02	.0208	274.99
18	S2	.08333334	8712	199/ 299	.3687	107.92	.3681	77.85
19	ETA2	.08507364	8712	199/ 299	.0129	125.66	.0099	356.86
20	MO3	.11924210	8712	199/ 299	.0052	231.32	.0046	310.62
21	M3	.12076710	8712	199/ 299	.0049	287.45	.0051	215.15
22	MK3	.12229210	8712	199/ 299	.0092	337.87	.0087	111.25
23	SK3	.12511410	8712	199/ 299	.0065	22.35	.0059	293.76
24	MN4	.15951060	8712	199/ 299	.0078	.97	.0083	227.55
25	M4	.16102280	8712	199/ 299	.0128	319.38	.0136	343.16
26	SN4	.16233260	8712	199/ 299	.0035	41.03	.0037	45.64
27	MS4	.16384470	8712	199/ 299	.0239	18.16	.0246	179.98
28	S4	.16666670	8712	199/ 299	.0112	99.51	.0112	39.36
29	2MK5	.20280360	8712	199/ 299	.0045	204.46	.0044	169.74
30	2SK5	.20844740	8712	199/ 299	.0017	354.75	.0015	236.09
31	2MN6	.24002200	8712	199/ 299	.0095	173.19	.0104	231.66
32	M6	.24153420	8712	199/ 299	.0208	172.13	.0228	27.81
33	2MS6	.24435610	8712	199/ 299	.0282	226.36	.0299	220.06
34	2SM6	.24717810	8712	199/ 299	.0086	308.87	.0088	80.61
35	3MK7	.28331490	8712	199/ 299	.0009	107.54	.0009	264.71
36	M8	.32204560	8712	199/ 299	.0018	341.77	.0020	29.34

Table D-6 Results for TG6

NUMBER OF VALID DATA = 599 AVERAGE = 2.18 STANDARD DEVIATION = .75
THEORETICAL RMS = .15 MATRIX CONDITION = .81
Olhao (Portugal) GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN 8710 15H 22/ 1/99 TO 14H 16/ 2/99
NO.OBS.= 600 NO.PTS.ANAL.= 600 MIDPT= 2H 4/ 2/99 SEPARATION =1.00

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	8710	199/ 299	2.1848	.00	2.1848	.00
2	MSF	.00282193	8710	199/ 299	.0270	6.49	.0270	291.23
3	O1	.03873065	8710	199/ 299	.0614	319.33	.0525	40.63
4	K1	.04178075	8710	199/ 299	.0698	77.86	.0637	10.19
5	M2	.08051140	8710	199/ 299	.9995	70.29	1.0301	86.90
6	S2	.08333334	8710	199/ 299	.3441	116.67	.3436	56.59
7	M3	.12076710	8710	199/ 299	.0079	296.44	.0082	321.21
8	SK3	.12511410	8710	199/ 299	.0045	23.62	.0041	255.88
9	M4	.16102280	8710	199/ 299	.0244	300.81	.0260	334.03
10	MS4	.16384470	8710	199/ 299	.0295	5.67	.0303	322.20
11	S4	.16666670	8710	199/ 299	.0092	88.75	.0092	328.60
12	2MK5	.20280360	8710	199/ 299	.0060	182.08	.0058	147.63
13	2SK5	.20844740	8710	199/ 299	.0009	29.91	.0008	202.08
14	M6	.24153420	8710	199/ 299	.0310	168.61	.0339	218.44
15	2MS6	.24435610	8710	199/ 299	.0326	222.16	.0345	195.30
16	2SM6	.24717810	8710	199/ 299	.0095	317.17	.0098	213.63
17	3MK7	.28331490	8710	199/ 299	.0015	88.73	.0015	70.89
18	M8	.32204560	8710	199/ 299	.0026	1.94	.0029	68.39

Table D-7 Results for TG7

NUMBER OF VALID DATA = 819 AVERAGE = .37 STANDARD DEVIATION = .66
THEORETICAL RMS = .06 MATRIX CONDITION = .42
Fuzeta (Portugal) GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN 8709 11H 25/ 1/99 TO 13H 28/ 2/99
NO.OBS.= 819 NO.PTS.ANAL.= 819 MIDPT=12H 11/ 2/99 SEPARATION =1.00

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	8709	199/ 299	.3807	360.00	.3807	360.00
2	MM	.00151215	8709	199/ 299	.0110	114.26	.0110	252.35
3	MSF	.00282193	8709	199/ 299	.1077	24.82	.1077	128.72
4	ALP1	.03439657	8709	199/ 299	.0018	120.05	.0016	356.76
5	2Q1	.03570635	8709	199/ 299	.0045	151.44	.0039	353.15
6	Q1	.03721850	8709	199/ 299	.0105	299.75	.0091	280.37
7	O1	.03873065	8709	199/ 299	.0641	335.24	.0548	94.62
8	NO1	.04026859	8709	199/ 299	.0038	165.26	.0037	190.72
9	K1	.04178075	8709	199/ 299	.0634	94.55	.0579	229.61
10	J1	.04329290	8709	199/ 299	.0082	181.53	.0073	100.02
11	OO1	.04483084	8709	199/ 299	.0112	123.35	.0071	113.00
12	UPS1	.04634299	8709	199/ 299	.0046	211.35	.0028	332.71
13	EPS2	.07617731	8709	199/ 299	.0172	174.02	.0183	187.10
14	MU2	.07768947	8709	199/ 299	.0643	172.56	.0667	325.42
15	N2	.07899925	8709	199/ 299	.1311	63.93	.1354	183.23
16	M2	.08051140	8709	199/ 299	.8298	73.58	.8551	331.03
17	L2	.08202355	8709	199/ 299	.0217	70.07	.0219	295.56
18	S2	.08333334	8709	199/ 299	.2674	120.30	.2670	120.22
19	ETA2	.08507364	8709	199/ 299	.0256	169.43	.0197	48.72
20	MO3	.11924210	8709	199/ 299	.0118	305.48	.0104	322.32
21	M3	.12076710	8709	199/ 299	.0011	251.32	.0011	97.36
22	MK3	.12229210	8709	199/ 299	.0144	54.73	.0135	87.25
23	SK3	.12511410	8709	199/ 299	.0056	85.27	.0051	220.26
24	MN4	.15951060	8709	199/ 299	.0335	67.52	.0356	84.27
25	M4	.16102280	8709	199/ 299	.0660	77.29	.0701	232.19
26	SN4	.16233260	8709	199/ 299	.0132	131.37	.0137	250.58
27	MS4	.16384470	8709	199/ 299	.0588	121.88	.0605	19.26
28	S4	.16666670	8709	199/ 299	.0152	194.04	.0151	193.88
29	2MK5	.20280360	8709	199/ 299	.0082	318.68	.0079	248.66
30	2SK5	.20844740	8709	199/ 299	.0009	133.17	.0008	268.08
31	2MN6	.24002200	8709	199/ 299	.0125	292.15	.0137	206.34
32	M6	.24153420	8709	199/ 299	.0228	284.16	.0249	336.52
33	2MS6	.24435610	8709	199/ 299	.0281	339.08	.0298	133.90
34	2SM6	.24717810	8709	199/ 299	.0092	58.28	.0095	315.58
35	3MK7	.28331490	8709	199/ 299	.0042	263.65	.0042	91.07
36	M8	.32204560	8709	199/ 299	.0055	279.89	.0062	229.69

Table D-8 Results for TG8

NUMBER OF VALID DATA = 573 AVERAGE = 1.46 STANDARD DEVIATION = .76
THEORETICAL RMS = .14 MATRIX CONDITION = .76
Tavira (Portugal) GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN 8713 12H 4/ 2/99 TO 9H 28/ 2/99
NO.OBS.= 574 NO.PTS.ANAL.= 574 MIDPT=10H 16/ 2/99 SEPARATION =1.00

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	8713	299/ 299	1.4525	.00	1.4525	.00
2	MSF	.00282193	8713	299/ 299	.0579	266.05	.0579	250.07
3	O1	.03873065	8713	299/ 299	.0676	311.16	.0579	225.23
4	K1	.04178075	8713	299/ 299	.0661	71.88	.0604	232.13
5	M2	.08051140	8713	299/ 299	1.0219	62.14	1.0528	139.47
6	S2	.08333334	8713	299/ 299	.3910	100.29	.3904	160.21
7	M3	.12076710	8713	299/ 299	.0025	283.76	.0026	39.62
8	SK3	.12511410	8713	299/ 299	.0012	224.92	.0011	85.10
9	M4	.16102280	8713	299/ 299	.0249	206.48	.0265	1.15
10	MS4	.16384470	8713	299/ 299	.0212	283.20	.0218	60.45
11	S4	.16666670	8713	299/ 299	.0022	28.43	.0022	148.27
12	2MK5	.20280360	8713	299/ 299	.0002	154.27	.0002	109.20
13	2SK5	.20844740	8713	299/ 299	.0010	21.03	.0009	301.13
14	M6	.24153420	8713	299/ 299	.0078	150.41	.0086	22.41
15	2MS6	.24435610	8713	299/ 299	.0111	204.61	.0117	59.20
16	2SM6	.24717810	8713	299/ 299	.0009	335.89	.0010	173.07
17	3MK7	.28331490	8713	299/ 299	.0003	151.32	.0003	183.58
18	M8	.32204560	8713	299/ 299	.0026	259.29	.0029	208.63

Table D-9 Results for TG9

```
NUMBER OF VALID DATA =   571  AVERAGE =  2.02  STANDARD DEVIATION =   .52
THEORETICAL RMS =    .10  MATRIX CONDITION =    .76
Cacela (Portugal)         GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS STN  5081 16H  4/ 2/99 TO 11H 28/ 2/99
NO.OBS.=   572  NO.PTS.ANAL.=   572 MIDPT=13H 16/ 2/99 SEPARATION =1.00
```

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	5081	299/ 299	2.0407	.00	2.0407	.00
2	MSF	.00282193	5081	299/ 299	.1147	34.05	.1147	15.03
3	O1	.03873065	5081	299/ 299	.0540	335.86	.0463	208.10
4	K1	.04178075	5081	299/ 299	.0537	90.34	.0491	205.47
5	M2	.08051140	5081	299/ 299	.6654	80.11	.6856	70.49
6	S2	.08333334	5081	299/ 299	.2000	112.57	.1997	82.49
7	M3	.12076710	5081	299/ 299	.0086	222.77	.0090	208.20
8	SK3	.12511410	5081	299/ 299	.0050	276.57	.0046	1.63
9	M4	.16102280	5081	299/ 299	.1771	112.85	.1880	93.61
10	MS4	.16384470	5081	299/ 299	.1086	151.12	.1117	111.43
11	S4	.16666670	5081	299/ 299	.0084	115.27	.0084	55.12
12	2MK5	.20280360	5081	299/ 299	.0082	84.36	.0079	180.26
13	2SK5	.20844740	5081	299/ 299	.0024	2.40	.0022	57.38
14	M6	.24153420	5081	299/ 299	.0383	114.60	.0419	85.75
15	2MS6	.24435610	5081	299/ 299	.0332	155.74	.0352	106.42
16	2SM6	.24717810	5081	299/ 299	.0054	177.84	.0056	108.07
17	3MK7	.28331490	5081	299/ 299	.0042	94.35	.0042	180.63
18	M8	.32204560	5081	299/ 299	.0093	98.30	.0105	59.82

Table D-10 Results for ADV

```
NUMBER OF VALID DATA =   213  AVERAGE = -5.04  STANDARD DEVIATION =   .55
THEORETICAL RMS =    .21  MATRIX CONDITION =    .97
Offshore (East, B.1)      GMT
ANALYSIS OF HOURLY TIDAL HEIGHTS  STN  9001 15H 4/ 2/99 TO 11H 13/ 2/99
NO.OBS.=   213  NO.PTS.ANAL.=   213 MIDPT= 1H  9/ 2/99 SEPARATION =1.00
```

NO	NAME	FREQUENCY	STN	M-Y/ M-Y	A	G	AL	GL
1	Z0	.00000000	9001	299/ 299	5.0450	180.00	5.0450	180.00
2	K1	.04178075	9001	299/ 299	.0386	77.48	.0352	19.95
3	M2	.08051140	9001	299/ 299	.6971	53.49	.7183	221.00
4	M3	.12076710	9001	299/ 299	.0075	336.90	.0078	228.02
5	M4	.16102280	9001	299/ 299	.0173	147.22	.0184	122.24
6	2MK5	.20280360	9001	299/ 299	.0013	314.65	.0013	232.14
7	2SK5	.20844740	9001	299/ 299	.0037	169.93	.0034	52.26
8	M6	.24153420	9001	299/ 299	.0040	72.40	.0044	214.93
9	3MK7	.28331490	9001	299/ 299	.0022	276.90	.0022	1.91
10	M8	.32204560	9001	299/ 299	.0020	78.54	.0022	28.58

ANNEX E: Atmospheric Pressure Data

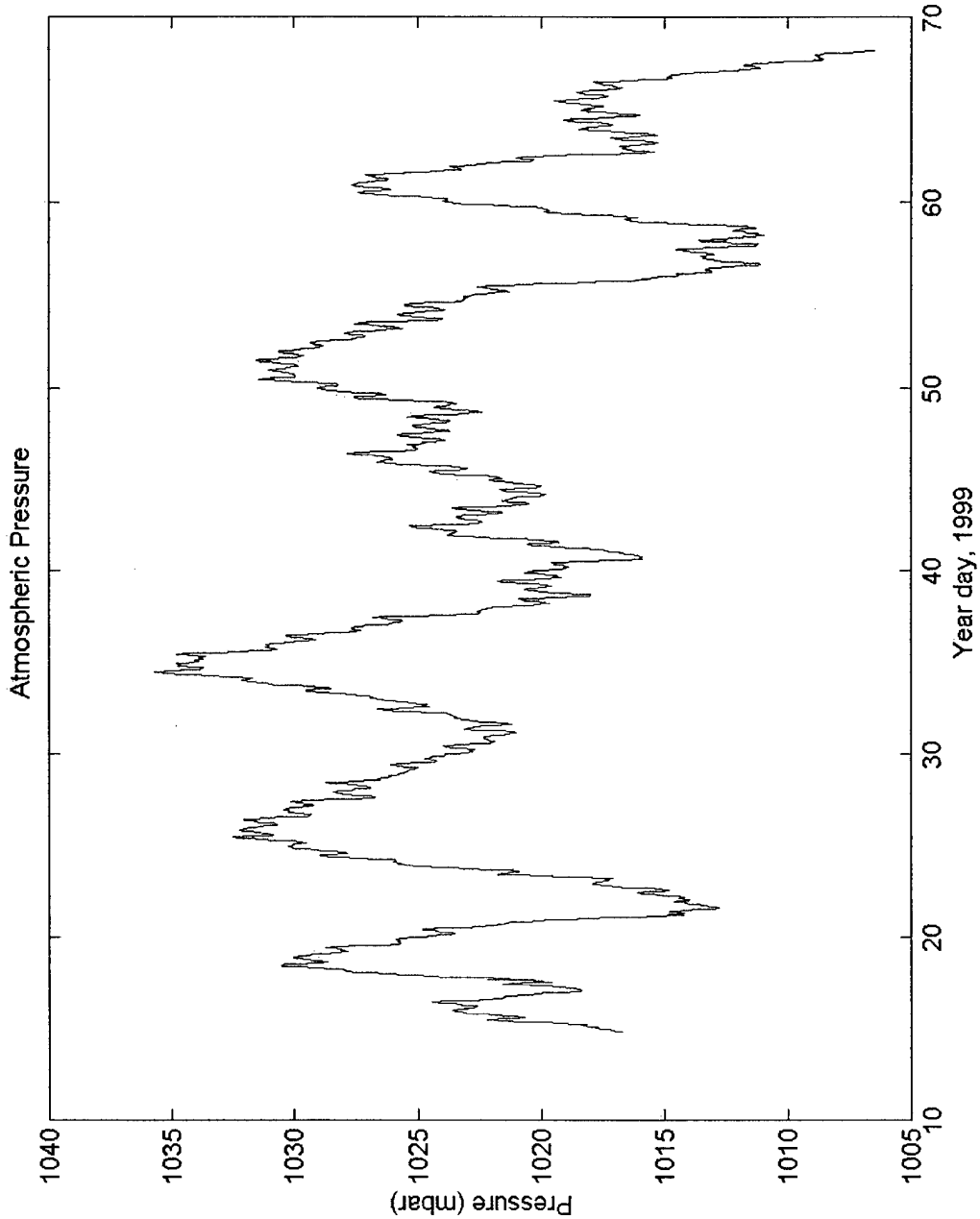


Figure E.1 Atmospheric Pressure Data.

ANNEX F: Electronic Data Format

The electronic data corresponds to the pressure data (tide gauges, ADV and atmospheric), bathymetric data and ADCP data collected in Portugal. Following is a description of the data format and structure. Each type of data is located in its own directory and in subdirectories when appropriate. Following details of the directory structure and file format for each data type.

PRESSURE DATA

Main Directory: "PressureData"

The Pressure data is organised in subdirectories corresponding to each tide gauge and the ADV pressure sensor (see Table 4.1 and Figure C.1.1 for name and location of tide gauges). Each subdirectory contains two text files: one with the raw data (*raw.dat) and the other with the pressure translated to water surface elevation and the atmospheric pressure removed. The water surface elevation is referred to the Hydrographic Datum (Z.H. , 2 m below the Mean Sea Level). The water density used was 1,024.5 $kg.m^{-3}$.

The format of the files is in columns as [year; month; day; hour; minute; second; pressure or water surface elevation (in meters of water)].

In addition, the atmospheric hourly data is contained in the subdirectory "Atmospheric". The format of this file is [year; month; day; hour; pressure (mbar); pressure (in equivalent meters of water)].

Note:
The water surface elevation appears not to be correct for some instruments. This is attributed to the poor quality and level of maintenance of some benchmarks used to survey the elevation of the pressure transducers.

BATHYMETRIC DATA

Main directory: "Bathymetry".

The bathymetric data is in XYZ format and is separated in files corresponding to each survey.

Note:
The horizontal position of the survey in Cacela is included to provide information about the actual position of the inlet.

ADV DATA

Main directory: "ADV".

The raw data is located in the "Raw" subdirectory and consists of two files for each sampling type. The sampling types (1 and 2) are described in Figure B.1.1.

The *.HDR files contain the burst header information. Note that this file includes data when the instrument was out of the water. The format is the following:

Table F.6-11 *.HDR File Type Format

Column #	Data Type and Units
1	Burst Number
2	Year – Time for start of first sample of burst
3	Month – Time for start of first sample of burst
4	Day – Time for start of first sample of burst
5	Hour – Time for start of first sample of burst
6	Minute – Time for start of first sample of burst
7	Second – Time for start of first sample of burst
8	Sampling rate (Hz)
9	Samples per burst
10	Recorder data byte
11	Sound speed (m/s)
12	Boundary range from probe tip (cm) (-0.01 if not detected)
13	Boundary range from center of sampling volume (cm; -0.01 if not detected)
14	Battery voltage
15	Mean signal strength, receiver 1 (counts)
16	Mean signal strength, receiver 2 (counts)
17	Mean signal strength, receiver 3 (counts)
18	Mean correlation, receiver 1 (percent)
19	Mean correlation, receiver 2 (percent)
20	Mean correlation, receiver 3 (percent)
21	Mean heading (°)
22	Mean pitch (°)
23	Mean rol (°)
24	Mean temperature (°C)
25	Mean pressure (dbar)
26	Standard deviation signal strength, receiver 1 (counts)
27	Standard deviation signal strength, receiver 2 (counts)
28	Standard deviation signal strength, receiver 3 (counts)
29	Standard deviation correlation, receiver 1 (percent)
30	Standard deviation correlation, receiver 2 (percent)
31	Standard deviation correlation, receiver 3 (percent)
32	Standard deviation heading (°)
33	Standard deviation pitch (°)
34	Standard deviation rol (°)
35	Standard deviation temperature (°C)
36	Standard deviation pressure (dbar)

The formatted data is contained in the subdirectory "Formatted" and has the time and mean velocity and pressure for each burst. The bursts for which the instrument was out of the water were removed.

The *.TS files contain the velocity data corresponding to each sample of all the bursts recorded. The format is the following:

Table F.6-12 *.TS File Type Format

Column #	Data Type and Units
1	Burst Number
2	Sample number
3	Velocity East ($cm.s^{-1}$)
4	Velocity North ($cm.s^{-1}$)
5	Velocity Up ($cm.s^{-1}$)
6	Amplitude, receiver 1 (counts)
7	Amplitude, receiver 2 (counts)
8	Amplitude, receiver 3 (counts)
9	Correlation, receiver 1 (percent)
10	Correlation, receiver 2 (percent)
11	Correlation, receiver 3 (percent)
12	Heading (°)
13	Pitch (°)
14	Rol (°)
15	Temperature (°C)
16	Pressure (dbar)

The water density used was 1,024.5 $kg.m^{-3}$.
The format for the pressure files is:
[year; month; day; hour; minute; pressure (m of water)]
The format for the velocity files is:
[year; month; day; hour; minute; velocity east ($cm.s^{-1}$); velocity north ($cm.s^{-1}$); velocity up ($cm.s^{-1}$)].

ADCP DATA

Main directory: "ADCP".

The ADCP data is contained in 6 subdirectories, one for each inlet. The data relevant for each subsection is in turn divided in 6 files, with a common prefix and a common suffix, and is organised as follows:

- * **bd_ *.dat** files: depth (m) of the center of each bin with respect to the water surface.
- * **bt_ *.dat** files: depth of the seafloor for each ensemble.
- * **ve_ *.dat** files: east velocity ($cm.s^{-1}$) for each bin (one ensemble per column).
- * **vn_ *.dat** files: north velocity ($cm.s^{-1}$) for each bin(one ensemble per column).
- * **x_ *.dat** files: x-position (UTM with WGS-84 datum) of each ensemble.
- * **y_ *.dat** files: y-position (UTM with WGS-84 datum) of each ensemble.

The prefix has the time of the beginning of the survey in HHMMSS.
The suffix has the name of the inlet and the subsection (e.g. A1, B3,...).

DOCUMENT LIBRARY

Distribution List for Technical Report Exchange – July 1998

University of California, San Diego
SIO Library 0175C
9500 Gilman Drive
La Jolla, CA 92093-0175

Hancock Library of Biology & Oceanography
Alan Hancock Laboratory
University of Southern California
University Park
Los Angeles, CA 90089-0371

Gifts & Exchanges
Library
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS, B2Y 4A2, CANADA

NOAA/EDIS Miami Library Center
4301 Rickenbacker Causeway
Miami, FL 33149

Research Library
U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Marine Resources Information Center
Building E38-320
MIT
Cambridge, MA 02139

Library
Lamont-Doherty Geological Observatory
Columbia University
Palisades, NY 10964

Library
Serials Department
Oregon State University
Corvallis, OR 97331

Pell Marine Science Library
University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882

Working Collection
Texas A&M University
Dept. of Oceanography
College Station, TX 77843

Fisheries-Oceanography Library
151 Oceanography Teaching Bldg.
University of Washington
Seattle, WA 98195

Library
R.S.M.A.S.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149

Maury Oceanographic Library
Naval Oceanographic Office
Building 1003 South
1002 Balch Blvd.
Stennis Space Center, MS, 39522-5001

Library
Institute of Ocean Sciences
P.O. Box 6000
Sidney, B.C. V8L 4B2
CANADA

National Oceanographic Library
Southampton Oceanography Centre
European Way
Southampton SO14 3ZH
UK

The Librarian
CSIRO Marine Laboratories
G.P.O. Box 1538
Hobart, Tasmania
AUSTRALIA 7001

Library
Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead
Merseyside L43 7 RA
UNITED KINGDOM

IFREMER
Centre de Brest
Service Documentation - Publications
BP 70 29280 PLOUZANE
FRANCE

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-2000-04	2.	3. Recipient's Accession No.

4. Title and Subtitle
Tidal Observations at Ria Formosa, Algarve, Portugal

5. Report Date
May 2000

6.

7. Author(s) Paulo Salles, Stephen P. O'Malley, George Voulgaris, David G. Aubrey

8. Performing Organization Rept. No.
WHOI-2000-04

9. Performing Organization Name and Address

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

WHOI Sea Grant
Mast III Program
UNAM

13. Type of Report & Period Covered
Technical Report

14.

15. Supplementary Notes
This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., WHOI-2000-04.

16. Abstract (Limit: 200 words)

The apparent persistence and stability of multiple tidal inlets in coastal lagoons are important for a variety of reasons, such as water quality, navigability and beach/barrier stability. To identify and study the processes controlling the persistence of multiple tidal inlets, the hydrodynamics of the system have to be better understood.

This project is part of a larger study (INDIA) examining general tidal inlet processes. The present components consist of a numerical simulation study of processes controlling multiple inlet stability, combined with exhaustive field measurements. This report addresses only the second component. The analysis uses as study site and main source of data the Ria Formosa lagoon in Portugal, which has multiple and historically persistent inlets.

For the numerical simulation model, field measurements are needed to provide (i) updated bathymetry of the inlets, in situ measurements of (ii) water level fluctuations within the estuary and (iii) flow velocities through the inlets.

This report gives first a brief description of the instrumentation used in the field (section 2), then describes the methods used to deploy the instruments, perform the surveys and gather the data (section 3), explains the procedures for data reduction and shows some results (section 4 and Annex).

17. Document Analysis a. Descriptors
Tidal Inlets
Tidal Distortion
Numerical Modeling

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Approved for public release; distribution unlimited.	UNCLASSIFIED	100
	20. Security Class (This Page)	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce